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# THE EFFECT OF RESPONSE AVAILABILITY ON PAIRED-ASSOCIATE LEARNING

by

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Abstract

Two hypotheses were considered concerning the effect of response availability on associative learning. The Underwood and Schulz (1960) "availability" hypothesis states that the response must be available in the response-recall sense before associative learning can begin. The alternative hypothesis states that response-learning and associative learning are independent processes.

In a 2 x 3 factorial design (Experiment #1), Ss either received response pretraining or had no response pretraining, and subsequently they learned a list of pairs and received 1, 3, or 6 paired-associate recall trials. Following paired-associate recall all the Ss received an associative-matching test in which both the stimulus and the response terms were present.

The paired-associate recall scores for the pretraining groups were greater than those for the no pretraining groups for the three and six-trial groups and these differences were significant statistically. On the associative-matching test there were only slight differences favoring the pretraining groups. The difference between pretraining and no pretraining groups in paired-associate recall was expected to remain in the associative-matching test if response availability facilitates associative learning, and the difference was expected to disappear if response-learning and associative learning are independent processes. The results essentially support the independent process hypothesis. There was

some evidence (Experiment #2) that the difference between pretraining and no pretraining groups in paired-associate recall scores was due to the fact that response availability exerts its influence on paired-associate scores at the time of recall rather than during associative learning. Some of the difference may also be due to pacing or other performance factors peculiar to the anticipation method of testing. It was concluded that the relationship between response-learning and associative learning may be more complicated than visualized in this thesis, and that response availability may have some facilitating effect on associative learning. However, the results of these experiments offer good reason to reconsider the Underwood and Schulz (1960) position concerning the necessity of response availability for associative learning, and to consider instead the alternative position that response-learning and associative learning are independent processes.

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CHAPTER I

# INTRODUCTION

The purpose of this thesis research is to determine whether prior learning of the responses to be used in a paired-associate task facilitates the rate of formation of associations. The question which prompted this research, then, concerns the relationship between response learning and the formation of associations between the stimulus and response members of the pairs. Broadly speaking, two alternatives may be considered--either the prior learning of the response facilitates the formation of associations, or it has no effect on whether or not an association can be formed.

The first alternative is considered in two ways--one by Underwood, Runquist, and Schulz (1959) and later by Underwood and Schulz (1960), and in the other way and in a somewhat different form by Saltz (1961). As considered by Underwood et al it may be called the availability hypothesis and as considered by Saltz, it may be called the differentiation hypothesis. Both of these hypotheses will be considered in some detail in the following chapter.

It has been shown clearly that learning a group of adjectives by a free-recall method (response familiarization) facilitates later paired-associate recall when these adjectives are used as response terms (Underwood, Runquist, & Schulz, 1959; Saltz, 1961; Runquist & English, 1964). This familiarization effect is considered by proponents of the "availability" hypothesis to be the result of

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making responses available to the S, or, from the Saltz point of view to be the result of differentiating the responses from each other before associative learning begins. In their extreme form these hypotheses state that the association cannot be formed until the response term is available or differentiated. It must be said, however, that the proponents of both these hypotheses have admitted the possibility that a response might develop associative strength to a particular stimulus without being available in the response-recall sense. Empirically this would be reflected by the S being able to recall the response term only when the specific stimulus term is presented.

The alternative view is that response learning and associative learning are essentially independent in that prior learning of the response terms has no influence on whether or not an association can be formed between that response term and a specific stimulus term. The facilitative effects on paired-associate recall which are produced by prior response familiarization, then, must be attributed to performance factors peculiar to the anticipation method of testing, or to the availability of the response at attempted recall and not during stimulus-response learning. This view receives support from the fact that during associative learning in the paired-associate task of the stimulus-response connection (which occurs when the response is presented with the stimulus), the response is present.

In order to test these alternatives, learning by the paired-associate anticipation recall method was followed by a variation of the associative-matching test (Horowitz, 1962). In the associative-matching test the Ss were given a list of the stimulus terms and a list of the response terms and required to match them up correctly. There was no pacing, i.e., having 2 sec. to respond to each stimulus term, but rather a generous overall time limit of 2 min. When used as a recall task, the associative-matching task appears to eliminate availability differences since all responses are immediately present. If response familiarization acts on paired-associate recall through availability, and this availability has an effect on associative learning, then, the matching technique should show response-familiarization effects also. If, on the other hand, associative learning is independent of availability, and this latter factor only affects paired-associate recall, response familiarization should have no effect on matching scores.

But before considering further this thesis problem, the theoretical background, out of which the problem arose, should be studied in some detail.

CHAPTER II

THEORETICAL BACKGROUND

The Underwood and Schulz Availability Hypothesis

Before looking closely at Underwood, and Schulz's "availability" hypothesis, it will be helpful to consider the verbal learning process, as these authors visualize it. Underwood, and Schulz believe that the acquisition of a serial or paired-associate list can be divided logically into two stages. The first stage will be called the response-learning or response-recall stage, and the second stage the associative or hook-up stage. The response-learning stage occurs temporally prior to the associative stage. During the response-learning stage, the S must learn to recall the response terms; Underwood, and Schulz think of it as making the responses available for the second or associative stage.

According to the two-factor verbal learning formulation,then, "availability" in the response-recall sense is a necessary occurrence before the associative stage can take place.

Response availability according to these authors depends upon frequency of experience. They have formulated a general hypothesis, called the "spew" hypothesis, which relates frequency of experience and learning. When the general "spew" hypothesis is applied to the verbal learning situation, it is called the "availability" hypothesis

A consideration of response availability in the verbal learning situation will follow an exposition of the "spew" hypothesis.

According to the "spew" hypothesis, the order of emission of verbal units is directly related to frequency of experience with those units. The "spew" hypothesis relates frequency of input of verbal units to the order of output of these units. To restate the hypothesis, when the S is faced with a relatively unstructured situation, the order of output of verbal units is directly related to frequency of input. It seems inevitable that individual differences in "spew" order could or should be related to differences in the nature of intake.

In a more structured situation, too, the order of emission is directly related to frequency of experience with those units, according to the "spew" hypothesis. In a learning situation in which the S is required to associate items and in which more than mere emission is required, the more frequently experienced items are more quickly available to be associated to other items. Therefore, according to Underwood and Schulz, these more available items start entering into association with other items earlier than less frequently experienced and therefore less available items. Provided that the associative connections between items develop at the same rate, the more available items will be emitted as responses in the new associative connection more quickly than the less available items. The rate at which the various new associative connections develop is a separate problem and is unrelated to the

"availability" hypothesis. According to the "availability" hypothesis, then, all other things being equal, the more frequently experienced item and thus the more quickly available item will be emitted more quickly in a new associative connection.

There are two kinds of responses--previously integrated responses and nonintegrated responses, and the response-learning process is different for both of these. If the response term is already a part of the S's repertoire as an integrated response (e.g., a common word), the response-recall stage consists merely in strengthening this response to this particular situation so that it has greater response strength than the many other responses in the repertoire which are not in the list the S is to learn. If, on the other hand, the response term is nonintegrated, than the response as an integrated unit is not in the S's repertoire (e.g., a consonant syllable such as QZB). Consequently, the S must connect or associate the response units (the letters Q, Z, and B) to form a larger unit. According to the "availability" hypothesis, once a response term has been integrated and is readily recallable as a unit, the second or associative stage can proceed; the S may now connect the response to the particular stimulus with which it is presented in the list. It is possible, of course, that the two stages may be complete for one item before the first stage is complete for another item. Underwood and Schulz (1960) admit the possibility that certain components of the response, e.g., the first letter, may develop associative strength to the stimulus before the entire response term is available.

To apply the "availability" hypothesis to the integrated materials of this thesis, assume the S is presented a paired-associate list consisting of response terms all fairly well integrated (in this case adjectives) but differing in frequency with which they have been experienced. Underwood and Schulz make the assumption that, when the S studies the response terms on the first learning trial, whatever mechanism is responsible for "spew" in the free-recall situation operates in this very restricted situation. The S will "spew" these responses in an order that reflects frequency; therefore, the more frequent response will be available first for the development of the associative connection with a specific stimulus.

In this study, frequency of experience of the response terms will be manipulated by response pretraining, so that the response terms will become available in the response-recall sense before the paired-associate list is presented. Since the response term is already a part of the S's repertoire as an integrated response, the response-recall stage consists merely in strengthening this response to the experimental situation, so that it has greater response strength than the many other responses in the repertoire which are not in the list the S is to learn. Perhaps it can also be considered that in the response-recall stage, the response terms are differentiated from the "pool of vocabulary" through recent repetition which is relevant to the experimental situation.

Saltz's Differentiation Hypothesis

Saltz does not talk of availability, but he does insist on the influence of response differentiation in controlling the rate at which a response term can be emitted as a response in an associative connection.

Saltz (1961) stated his view that association is not a critical factor in verbal learning, and states that if the S had to learn a single pair, the learning would occur in very few trials. The critical factor is differentiation of the stimuli and of the responses to be learned, and he defines differentiation as between stimuli and between responses. Saltz has proposed the following assumptions concerning the differentiation process. As these assumptions are somewhat vague, it would be in the interests of avoiding further confusion to present them in Saltz's own words (Saltz, 1961, p. 583).

1. Initial differentiation: The initial differentiation of an item, for a S, can be defined to be a function of the similarity between this item and other items in a list. The less the similarity, the greater the differentiation.

2. Development of differentiation: Differentiation of the term can be defined as increasing as a function of the frequency with which the term has been presented and responded to (e.g., "familiarization" training, Noble, 1955).

3. Response differentiation: Increased differentiation of the response term, in an S-R pair, is assumed to increase the probability that the term will be emitted as a response--though not necessarily to its appropriate stimulus.

4. Stimulus differentiation: Increased differentiation of the stimulus term is assumed to increase the probability that the stimulus term will elicit its appropriate response. In other words, response differentiation is required for emission of a term, but it will not be elicited consistently by its appropriate stimulus until that stimulus is also differentiated.

5. Oscillation of differentiation: Both stimulus and response differentiation oscillate randomly and independently from trial to trial, reducing the effective differentiation from that which would be predicted solely from the initial and developed degrees of differentiation. However, the magnitude of oscillation decreases as a function of increased differentiation.

Saltz thinks pretraining does more than merely make the relevant responses available to the S. He says pretraining is predifferentiation and that response differentiation is a more basic variable from which variables such as availability can be predicted.

In Saltz's view, then, not only does the associative phase depend upon the response-learning phase and availability of the response, but in his differentiation view of learning, differentiation of stimuli from each other and responses from each other are so important that association between the stimulus and the response is not considered a critical factor in verbal learning.

It is not clear in Saltz's formulations how response differentiation is supposed to work, nor is it clear how the differentiated stimulus elicits the differentiated response. Furthermore, little experimentation has been done related to

the widely accepted Underwood, and Schulz notion of "availability". For these two reasons--the lack of clarity of the differentiation notion and the lack of experimentation related to it, the availability hypothesis will be considered almost exclusively from now on in this thesis concerning the relationship between the response-learning and associative stages of verbal learning.

To sum up, it may be stated that response learning and the formation of stimulus-response associations can also be considered independent processes. The response-learning stage of paired-associate learning may or may not be a necessary antecedent of the associative stage. Underwood, and Schulz believe the responses must be available (in part at least) before associations can be made. They believe frequency of experience underlies the "spewing" of responses in the free-assocation situation and that frequency of experience underlies the availability of responses for association in the more restricted verbal learning situation. Yet, since the response is present during the actual associative learning, it is possible that response availability is not necessary for associative learning to take place.

In the next chapter evidence relevant to the Underwood, and Schulz view, especially, will be considered. Before reviewing this evidence, some of the terms as they are used in this thesis will be defined. The terms and their definitions are as follows:

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Response integration--the process of connecting or associating the letters of a response term to form an integrated unit;

Response learning--the presentation of the response term in pretraining or during paired-associate learning, so that it becomes integrated and available;

Response-recall--the recall of the available responses on a pretraining test trial;

Response availability--the state of readiness of the learned response term to be recalled, or, to enter into associations;

Associative-learning--the process of associating or connecting the stimulus terms and the response terms to each other;

Paired-associate learning--the total learning of the list of pairs, including response learning and associative learning;

Paired-associate recall--the recall performance on a paired-associate test trial.

## CHAPTER III

## RELEVANT RESEARCH

This thesis deals with manipulated frequency and some literature on it will be reviewed in detail. First though, in the interests of giving a broader background for these studies certain other findings relevant to Underwood, and Schulz's "spew" hypothesis will be reviewed.

### Spewing of Responses and Frequency of Experience

Some studies have directly suggested the "spew" hypothesis. Two studies show that in a classical free-association test, in spite of some presumed restriction on the appropriate responses caused by the particular stimuli employed, the responses which occur most frequently to stimuli are those which have the highest frequency in everyday usage (Johnson, 1956; Howes, 1957).

Similar results were found when Ss were given categories and asked to give four specific associations (Cohen, Bousfield, & Whitmarsh, 1957). In another experiment, for the category "male first names" the order of recall of eight names and frequency of contact with the person represented were correlated very highly (.96). Frequency of contact was measured by the S's rankings of the amount of contact with each person represented. This correlation is interpreted as meaning that frequency of contact, hence, probably frequency of name emission, is closely related to the order of output (Cromwell, 1956). Bousfield, and Barclay (1950) asked their Ss to name as many members of a class, e.g., birds, as they

could. The results leave no doubt that the order of emission and frequency are highly related.

To restate the hypothesis, when the S is faced with a relatively unstructured situation, the order of output of verbal units is directly related to frequency of input.

Measured Frequency and Learning Rate

Frequency of input also determines the order of availability of a response for association in a more structured paired-associate or serial learning situation.

It might be noted at this point, that for analytic purposes paired-associate learning is much superior to serial learning, since the role of the stimulus and the response are not confused in paired-associate learning. For this reason most of the findings reviewed will be of paired-associate learning as measured by paired-associate recall scores. The paired-associate studies to be reviewed have made use of the paired-associate anticipation recall method.

The relationship between frequency of experience and recall has pointed to frequency of experience as a possible factor underlying differences in learning rate.

(a) Thorndike-Lorge Word Count. Thorndike-Lorge frequency values indicate occurrences of words in writing. Several studies have been done comparing recall of serial lists differing in Thorndike-Lorge frequency values and these have shown a clear positive relationship between frequency and mean recall (Hall,

1954; Bousfield, & Cohen, 1955; Bousfield, Cohen, & Whitmarsh, 1958). In absolute terms the differences are small, however. This might be due to the high absolute frequency of even the so-called low frequency words.

A study done for another purpose reports a subsidiary finding of a correlation of .74 between the Thorndike-Lorge values and number of times a response was recalled correctly in paired-associate learning. The stimulus terms were nonsense syllables (all of approximately the same M), and the response terms were words varying in Thorndike-Lorge frequency. The complete range of Thorndike-Lorge frequency is involved. Thus, this study suggested a clear positive relationship between frequency and learning when the words are used as response terms in a paired-associate list (Jacobs, 1955).

(b) Single Letter, Bigram, and Trigram Frequency. Many studies have been done, especially by Underwood, and Schulz (1960), relating frequency of experience of these smaller units to recall. Frequency of experience of these units has been ascertained in several ways. Counts were made of the occurrences in literature of letters (U count as reported in Underwood and Schulz, 1960), bigrams (U count and Thorndike-Lorge count, both reported in Underwood, and Schulz, 1960), and trigrams (U count, Thorndike-Lorge count and Pratt's 1939 count). Emitted frequency of these units, however, was considered a more accurate indication of the Ss' frequency of experience of these units, than was frequency

of occurrence in literature; in emitted frequency counts all of the Ss' experiences with these units would be reflected, not merely Ss' reading experience. To determine emitted frequency Ss were given one and two-letter combinations and asked to respond with any letter which most naturally follows the unit given (Underwood, & Schulz, 1960). Trigrams were generated and assigned values according to the frequency of emission of each letter relative to the other letters emitted for each combination. Emitted frequency was measured by the generated values of the trigrams.

Emitted frequency and recall were highly related when the trigrams were response terms. However, the relationship between pronunciability and recall was even higher than that for emitted frequency. The relationship of pronunciability to learning as measured by recall was postulated to be due to pronunciability's relationship to frequency. Sounds serve as integrating devices for nonsense material because of great emitted frequency in the past. It was expected further that, if the generated values could be calculated to take into account the relative importance of the first, second, and third letters of the trigrams for the Ss, then generated values would be as accurate as predictors of recall as pronunciability. In addition generated values would predict for the special habits for which pronunciability breaks down, e.g., alphabetical sequences.

The relationship between frequency and learning as measured by recall is not as clear when the measure of frequency is the number of occurrences in literature of these units. In experiments in which single letters, bigrams, and trigrams were response terms. Underwood, and Schulz found that recall was a function of frequency of use as defined by counts of these units in literature. However, the relationship between frequency and learning was a decreasing function of the number of letters in the response unit. Underwood, and Schulz interpret this to mean that, as the number of letters in the response increases, there is a corresponding increase in the problems of integration, and since degree of integration apparently cannot be predicted from printed language frequency of the two and three-letter combinations in words, the relationship between frequency and learning breaks down as the number of letters in the response increases. Pronunciability, it may be noted, is a better indication of integration than is frequency of occurrence of three-letter units in literature, since the most frequently <u>emitted</u> units are pronounceable ones.

In comparing words and nonwords, Underwood, and Schulz found that equal frequency of words and nonwords (as measured by counts of these units in literature) does not produce equal recall. This finding supports the frequency hypothesis since words as intact units may be more available than nonwords in a response-recall sense because of greater emitted frequency. Words, therefore, do not have to be integrated before they can appear as responses.

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All things considered, Underwood, and Schulz conclude, and it is consistent with the findings from their varied research with nonintegrated materials, that the "spew" facet of their frequency hypothesis remains tenable for the response-learning stage of verbal learning.

Manipulated Frequency and Learning

Manipulated frequency studies are crucial to the "spew" hypothesis and to this thesis research since, if it is frequent experience of an item that causes it to be more available, then manipulating frequency will have the same effect on subsequent paired-associate learning as that shown in the other studies on measured frequency and learning.

In this section only studies using nonintegrated nonsense material will be reviewed. Findings dealing with familiarization of previously integrated materials will be reviewed later.

Noble's studies first indicated that the relationship between familiarity and frequency was not an artifactual one. Noble (1954) chose 16 items from the low end of his scale of dissyllables and presented these for different frequencies of from 0 to 25 times. Following this, the S rated the 16 words on a familiarity scale. There is a direct relationship between scaled familiarity and frequency of original presentation. The curve for the relationship was clearly negatively accelerated, indicating that beyond a certain number of presentations, scaled familiarity did not increase much.

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Noble than reasoned (1955) that if the relationship between familiarity and frequency is not an artifactual one, those items given the most familiarization training should be learned most rapidly. For this study he chose six items having very low M; the amounts of familiarization training were 0, 1, 2, 3, 4, 5, 10, and 20 trials. The results show that rate of learning to recall an item is directly related to number of familiarization trials. Little effect is noted, however, with items given between 1 and 5 familiarization trials. The relationship is clearest when 0, 10, and 20 trials are considered.

Hovland and Kurtz (1952) have shown that a familiarization procedure for moderately low association Glaze syllables facilitated somewhat the recall of serial lists made up of the familiarized syllables. This was later confirmed by Riley and Phillips (1959).

Waters (1939), Sheffield (1946), and Underwood and Schulz (1960) have investigated the effect of stimulus and response familiarization in paired-associate learning. Waters' experiments showed that familiarization of both the stimulus and response syllables had no effect on subsequent paired-associate recall. His experiments have given absolutely no support to the relationship between manipulated frequency and learning. In the experiments of Sheffield, and Underwood, and Schulz, however, response familiarization facilitated subsequent paired-associate recall; stimulus familiarization either had no effect upon, or slightly inhibited subsequent paired-associate recall.

The to-be-familiarized units were nonsense syllables for all these studies, and the other members of the pairs were common three-letter words (Sheffield) or nonsense syllables (Waters, and Underwood, and Schulz). Underwood, and Schulz also used paralogs as the non-familiarized members of pairs. Various familiarization procedures were used, i.e., during presentation the S was required to pronounce or spell the syllables; the to-be-familiarized syllables were presented alone or they were presented as responses in a noun-syllable or nonsense-form-syllable familiarization list; there were various methods of testing for response learning. The numbers of familiarization trials gives were 1, 10, 20, or 40 for Underwood, and Schulz, and either 10 or 20 trials for Sheffield. In Waters' experiments less familiarization training was given, the maximum number of trials in any group totalling about seven.

In one Underwood and Schulz experiment, it was shown that only at the 40-trial level of relevant response familiarization was there a clear indication of facilitation as compared to the one-trial level of familiarization. The reason Waters' experiments did not show facilitation effects, then, is probably because he did not have enough familiarization trials.

The "spew" hypothesis and the "availability" hypothesis relating frequency of experience to paired-associate learning speed receives support from the recall scores of these manipulated frequency studies with nonintegrated response units.

In these studies there was no effect of stimulus familiarization, in fact, more often than not, stimulus familiarization produced an inhibitory effect. In much of this work there was some opportunity for interference to take place during the familiarization procedures, and this could account for the inhibitory effect sometimes found. The details will not be given since this problem is tangential to the thesis problem.

Studies of M

Many factors may be expected to affect paired-associate learning, among them frequency of prior experience of the materials used, meaningfulness as defined by association values (M), motivation at the time of the experiment, and various emotional factors. The effects of these variables may be reflected in either or both of the two stages. Attention in this section will be focused on M especially but also on frequency since much of the work on M was carried out in conjunction with that on frequency.

In studies relating M to learning it has been found that the effect of stimulus M on recall is less than that for a corresponding range of response M. In all these studies (Sheffield, 1946; Kimble & Dufort, 1955; Cieutat, Stockwell, & Noble, 1958; L'Abate, 1959) the paired-associate anticipation recall method was used, and the materials used varied. The two-stage analysis readily accounts for this gross difference. When an item is in the stimulus position, no response recall is involved for the stimulus; only responses are

involved in response recall. The stimuli are influenced by M only in the associative stage.

Underwood, & Schulz (1960) have concluded, and the results of studies investigating the relationship between response M and learning are consistent with the conclusion, that M's effect occurs because of M's correlation with frequency of experience of that item.

However, particularly in view of certain of Underwood, and Schulz's findings (1960), it seems the effect of association value as well as that of frequency may be important for the response-learning stage of paired-associate learning.

Forty-two items were submitted to a production test to determine association value. For twenty-two of these items the correlation between association value and pronunciability was .92, but pronunciability tended to predict recall better than association value.

The fact that association value and pronunciability were here found to be highly correlated and association value a predictor of recall as well as pronunciability, suggests association value may predict recall because of its correlation with pronunciability. However, it is not conclusively shown by the data of Underwood, and Schulz's experimentation that association value is not a fundamental component in the rote-learning process. The results of the association test support those found by Noble (1952) and cast further doubt (see also Archer, 1961) on the reliability of the Glaze and Kreuger

association values, upon which many of the Underwood, and Schulz studies on frequency and M have been based. Furthermore, in a verbal-discrimination experiment in which response-recall was not necessary Runquist and Freeman (1960) studied the effects of familiarization (of both the stimulus terms and the response terms) and association value. The results essentially supported a response-oriented interpretation of the effects of association value and familiarity. Association value may have some influence on response-recall, but the response familiarization studies show frequency of experience to be the main determinant of response-recall.

The lack of stimulus familiarization effects generally found may be interpreted to mean that number of associations may facilitate the associative stage of learning especially, since familiarization training does not increase the number of associations elicited by an item (Riley, & Phillips, 1959). This viewpoint receives further support since stimulus M has been shown to be related to recall while frequency (familiarization) has not.

Two more studies which bear on the relationship between M and learning in the two verbal learning stages, will be reviewed briefly. Epstein, and Streib (1962) compared low M-high M pairs (L-H) and high M-low M pairs (H-L) in three learning conditions, namely, an anticipation condition and two recognition conditions. One recognition condition was an easy one in which a correct response term and two different and unfamiliar response terms were presented together as possible responses for a stimulus term. The other

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recognition condition was a difficult one in which a correct response term and two other response terms from the list were presented. They found that in the anticipation learning condition (in which response-learning was necessary) the L-H list was learned in less trials. Under the condition of easy recognition, the L-H and H-L lists required an identical number of trials to mastery. However, in the difficult recognition condition the H-L list was learned in significantly fewer trials than the L-H list. Epstein and Streib have considered this facilitation may be ascribed to the greater associative probability of high M stimuli. The presumed facilitating effect of stimulus M was considered to be masked by difficulty in response learning under the anticipation condition and not to be discernible under the condition of easy recognition due to the rapid acquisition of both lists.

In another study, carried out to test Epsein, and Streib's associative-probability interpretation of their results, Epstein (1963) used response pretraining instead of the recognition test since the recognition test caused some interpretative difficulties. Using L-L, H-L, L-H, and H-H groups and using Noble's paralogs, he found very different results:

(1) Prior item learning facilitated the acquisition of all four lists;

(2) With response M constant, variation in stimulus M did not influence speed of acquisition; (This finding is contrary to what has been found by other investigators as well, in experiments in which response availability was not controlled for.)

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(3) Response M was a significant source of variance. There are various methodological problems in both experiments which have possibly contaminated the results, but in the face of the findings from these experiments one would not be justified in saying that either stimulus or response M was not important in paired-associate learning.

There are several other findings bearing on the influence of M on the response-learning stage and on the associative stage, but since this topic is not directly relevant to this thesis topic, these findings will not be presented. It suffices to say that M may have some effect, along with frequency on the response-learning stage and probably it has more effect on the associative stage. For the response-learning stage most of the effect of M which is found operates via frequency instead of associations.

A Brief Summary

So far, in this review of relevant research, a broader background for the specific problem of this thesis has been given. It has been found that frequency of experience of integrated and nonintegrated materials as measured by various frequency counts is related to recall. Emitted frequency of nonintegrated units is especially highly related to recall. These relationships between frequency and recall are found in serial and paired-associate learning, especially when the frequency is of the response units.

Manipulated frequency of nonintegrated materials is also related to recall. Familiarization of the response term facilitates subsequent

paired-associate recall, but familiarization of the stimulus term does not.

As related to the two-stage conception of verbal learning proposed by Underwood, Runquist, and Schulz (1959), and elaborated upon by Underwood, and Schulz (1960), the findings on frequency and recall suggest frequency is sufficient, or nearly sufficient for the response-learning stage, but is not important for the associative stage. Association value, it may be added, is probably important for the associative stage, but has little importance in determining response learning. The "spew" hypothesis has been supported as it relates to response learning ("availability" hypothesis).

The "Availability" Hypothesis

Underwood, Runquist, and Schulz (1959) published an article showing that response pretraining of adjectives aided the paired-associate recall of nonsense syllable-adjective pairs as compared with control groups with no pretraining and irrelevant response pretraining. The effect was especially evident with low similarity responses rather than with high similarity responses, although it was also present in the latter. Response learning took place during paired-associate learning; this was evidenced by stopping several groups after an appropriate number of paired-associate trials, and asking the Ss to write down all the responses they could remember. Though response learning took place it was not shown that it actually facilitated paired-associate learning. Since response

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recall for both high and low similarity responses was much better than paired-associate recall scores, response learning and availability in the response-recall sense, could have aided associative learning, but the Underwood, et al experiment cannot answer the question of whether formation of the associations is actually facilitated by response pretraining.

Saltz (1961) conducted an experiment to determine if pretraining amounts to anything more than making the relevant responses available to the S. He supposedly found that making responses available to pretraining and no pretraining groups alike during paired-associate learning did not cause the no pretraining groups to do as well as the pretraining groups at recalling the pairs. To make responses available during paired-associate learning, a card with all the relevant response terms was placed in the top of the memory drum. The response terms were numbered serially from 1 at the top of the card to 10 at the bottom. The S was instructed to respond by giving the number appropriate to the response he thought was correct. Five different orders of response terms were used so that the number associated with any given response changed from trial to trial. This supposedly obviated the tendency for Ss to learn a number-response association, and forced the Ss to examine the card for each response. Saltz concluded from the results of his experiment that in pretraining the responses were differentiated from each other, in addition to being made available, since pretraining facilitated paired-associate

recall despite the fact that all the response terms were present in his paired-associate learning procedure.

Runquist, and English (1964) recently published an article which throws doubt on Saltz's findings. They found that the relevant response pretraining group was not statistically significantly better than the irrelevant response pretraining group in paired-associate recall when the search time for the correct response was paced, i.e., was 4 sec. long as in the Saltz experiment. However, the relevant response pretraining group was much inferior to the irrelevant response pretraining group when the search time was unpaced, i.e., when the S had unlimited time to respond. While these somewhat surprising results would indicate the card-searching method produces other effects than simply forcing availability, still the results suggest that Saltz's paced method did not force availability. It is further doubtful that Saltz really made responses available, since some Ss reported that they did not have time to make use of the response-term list in the paced 4 sec. recall condition.

Furthermore, Schulz and Lovelace (1964) point to a difference in location latencies for items of low M and high M, i.e., it takes a S longer to locate an item of low M on a multiple-choice test than it takes to locate an item of high M. This is a possible source of error in multiple-choice designs which must be heeded in studies of response M. In view of the high correlation between frequency and M, locating the responses in the card-searching method would take less time for the pretraining groups than for the no pretraining groups.

Saltz's study, then, does not provide evidence that response pretraining amounts to more than making the relevant response terms available to the S; the basic problem still concerns the role of response availability in paired-associate learning.

This thesis experiment is another attempt to test the importance to associative learning of response availability as it is indicated by response-recall during pretraining. It is designed to be a direct test of the relationship between the response-learning and associative stages of paired-associate learning. That is, this thesis proposes to be a test of whether response availability facilitates associative learning, or whether it merely facilitates paired-associate recall. Since the response is present during learning of the stimulus-response association, it may that availability in the response-recall sense is irrelevant to associative learning.

To circumvent some of the problems encountered in the card-searching procedure and, perhaps more important to have a separate test of associative learning and the effect of response availability on it, the design consists of various amounts of paired-associate learning and recall trials followed by Horowitz's (1962) associative-matching procedure. In the associative-matching test the S is given all the stimulus terms and all the response terms and is required to match the responses to their respective stimuli. Since on the associative-matching test any effects of incomplete response availability and of pacing are eliminated, this test is a direct test of associative learning. If availability is a necessary antecedent of associative learning,

then the pretraining groups will perform better on the associative-matching task as well as on the paired-associate recall task, provided there is no special effect of pacing. However, if the pretraining group superiority in paired-associate recall is caused by performance factors, such as availability of the response term at attempted recall but not during associative learning, or a special effect of pacing, then there will be no difference between the pretraining and no pretraining groups on the associative-matching test.

# CHAPTER IV

## PROCEDURE - MAIN EXPERIMENT (#1)

### Materials

The stimulus terms were ten trigrams of between 46% and 53% association value on both Archer's (1960) norms and Glaze's (1928) norms; these trigrams were of low formal similarity. The response terms were adjectives low in both formal and meaningful similarity. They all rated between 4 and 16 on the general frequency rating of the Thorndike-Lorge scale and were quite familiar, scoring between .6 and .8 on Haagen's scale of adjectives, all of which are quite common words. The adjectives used had an average vividness rating of 3.2, which is at about the middle of Haagen's vividness range. Trigrams were paired randomly with the adjectives, and checked to eliminate any obvious associations. The list is shown in the Appendix.

### Subjects

There were 144 Ss, 72 males and 72 females, serving for this experiment. The numbers of males and females in each group was not balanced; the number of males and females in each group of 24 Ss ranged from 9 to 15. All Ss were from the Introductory Psychology class and were serving to obtain course credit; they signed up knowing only that they would be serving for a verbal learning experiment. It was later ascertained which Ss were previously practised in verbal learning experiments and which were not. Ss were assigned upon appearance at the laboratory to the condition scheduled next. The six conditions were run consecutively from the first to the

last and then in reverse order. An experimental condition alternated with a control condition. A total of 33 Ss were rejected for various reasons: 17 Ss did not complete the associative-matching test due to incomplete instructions given; 8 Ss were tested under different experimental conditions--different projector and different room; 5 Ss did not complete paired-associate learning due to extreme difficulties with the projector; 2 Ss misunderstood the instructions; and, 1 S was not an Introductory Psychology student.

General Design

There were two basic groups of 72 Ss each, divided into three subgroups of 24, thus comprising a 2 x 3 factorial design. Of the two main groups one group received 10 trials of relevant response pretraining and response-recall or familiarization up to a criterion of two consecutive errorless trials while the other group received no response pretraining. The three subgroups received either 1, 3, or 6 trials of recall on the paired-associate list. The paired-associate anticipatory recall method was used. Paired-associate learning was followed by an associative-matching test at the conclusion of the prescribed number of recall trials. The pretraining groups receiving either 1, 3, or 6 paired-associate recall trials will hereafter be designated P1, P3, and P6 respectively, and the no pretraining groups will be designated NP1, NP3, and NP6. The design is as illustrated in Table 1.

TABLE 1

EXPERIMENTAL DESIGN

| | | | |
|---|---|---|---|
| 1. | Pretraining | 10 trials maximum (P) | none (NP) |
| 2. | Paired-Associate Anticipation Learning | 1, 3, or 6 recall trials | 1, 3, or 6 recall trials |
| 3. | Associative-Matching Test--was given to all groups after paired-associate learning | | |

Response Pretraining

Following a short instruction to those groups having response pretraining, the response terms were presented. Presentation was by means of a Dunning Animatic 16 mm. Filmstrip projector which projected the material onto an 8 x 8 in. translucent window. This window was centered at approximately eye level in a larger opaque screen, which was arranged so that the S could see neither the experimenter nor the projector. Response terms were presented at a 2 sec. rate. The S was instructed to read each adjective aloud as it appeared and to remember as many as he could. The actual instructions appear in the Appendix. There were 10 different orders used, a different order on each trial. Orders were first arranged by means of the Table of Random Numbers then checked so that they were all quite different, i.e., sequences of three or more words did not appear more than once and two-word sequences never appeared more than twice. After each trial the S was given a sheet of paper with 10 blank spaces, and he was asked to write down all the words he could remember in any order in which they occurred to him. For this response recall 1.5 min. were allowed.

Paired-Associate Learning

Immediately following response learning, the S was read the standard paired-associate instructions, followed by the allotted number of recall trials. The instructions are given in the Appendix. Presentation was by a projector onto a screen as in pretraining. The stimulus term was presented alone for 2 sec. and

the stimulus-response pair for another 2 sec. A 4 sec. unfilled rest interval separated recall trials. There were seven different orders of the pairs used to minimize serial associations, and these orders were again arranged by using the Table of Random Numbers.

Since the S was not able to anticipate and say aloud a response to a particular stimulus until he had seen it paired with that stimulus at least once, the first trial was a learning trial only. The second learning trial, then, was really the first recall trial.

It may be asked why the maximum number of recall trials in this experiment is only six. In the Underwood, Runquist, and Schulz experiment 15 trials of paired-associate recall were given and in the Saltz experiment 17 trials were given. In a previous unpublished study, however, it was shown that when more than six paired-associate recall trials were given too many Ss were getting perfect scores on the associative-matching test. The associate-matching test was useless since any differences between pretraining and no pretraining groups could not show if they were present

Associative-Matching Test

When the S had completed his allotted number of anticipation trials, the experimenter read another short instruction (see Appendix) and handed the S an associative-matching test. This was a sheet of paper on which the trigrams were listed on the left, each followed by a blank space. The response terms were

listed on the right in a scrambled order. The Ss were required to write the appropriate response term for each trigram in the blank space next to it, and they were asked to fill in all blanks. They were given 2 min. for this task. There were four different recall sheets used. An equal number of Ss in each condition received each sheet. On these recall sheets both the stimulus terms and the response terms were in different scrambled orders. These orders were different from those used on any previous part of the experiment.

Equipment Problems

The equipment used for almost half of this experiment was faulty and this caused some procedural inconsistencies. The Ss tested with faulty equipment and with good equipment are indicated in the Appendix. There were no large differences in data means or distributions for Ss tested with faulty and good equipment, and their data was therefore combined.

## CHAPTER V

## RESULTS - EXPERIMENT #1

### Response Pretraining

The progression of response-recall for groups P1, P3, and P6 is shown in Figure 1. It is obvious that the curves for the three groups are highly similar. Response-recall progressed uniformly for all three groups. This shows that for response learning, anyway, the three pretraining groups are of comparable ability. Furthermore, Figure 1 shows that at the commencement of paired-associate learning the three pretraining groups had apparently learned the responses to an equal degree and, therefore, should have the same advantages in paired-associate recall.

### Paired-Associate Learning

The paired-associate recall scores for each trial are shown for the six groups in Figure 2. As can be seen, there is considerable variability between the scores for different groups at each level.

Two measures were used for statistical comparisons of paired-associate recall--the final-trial score and the combined-trial score, which is the sum of the scores for all trials of the particular group. The first score was used because of interest in comparisons at a particular level, while the second score was used to include all the data, and, as the more stable measure since it controls for trial to trial fluctuations. The mean score values for the final-trial measure and the combined-trial measure

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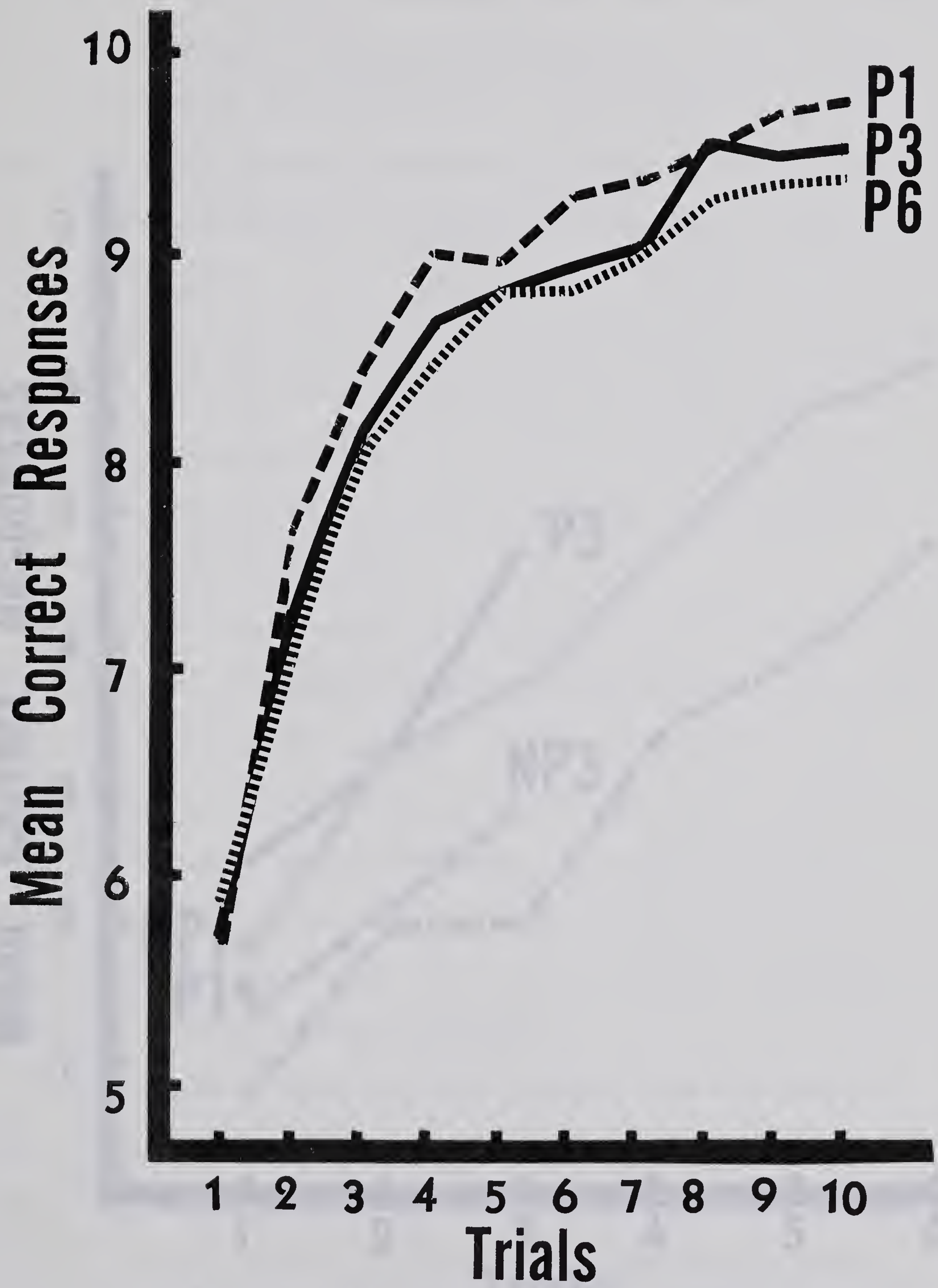


Figure 1. Mean Correct Responses Recalled by the Pretraining Groups of Experiment #1 on Successive Response-Recall Trials.


Figure 2. Mean Correct Responses Recalled by the Participating Groups of Experiment #1 on Successive Responses-Recall Trials.

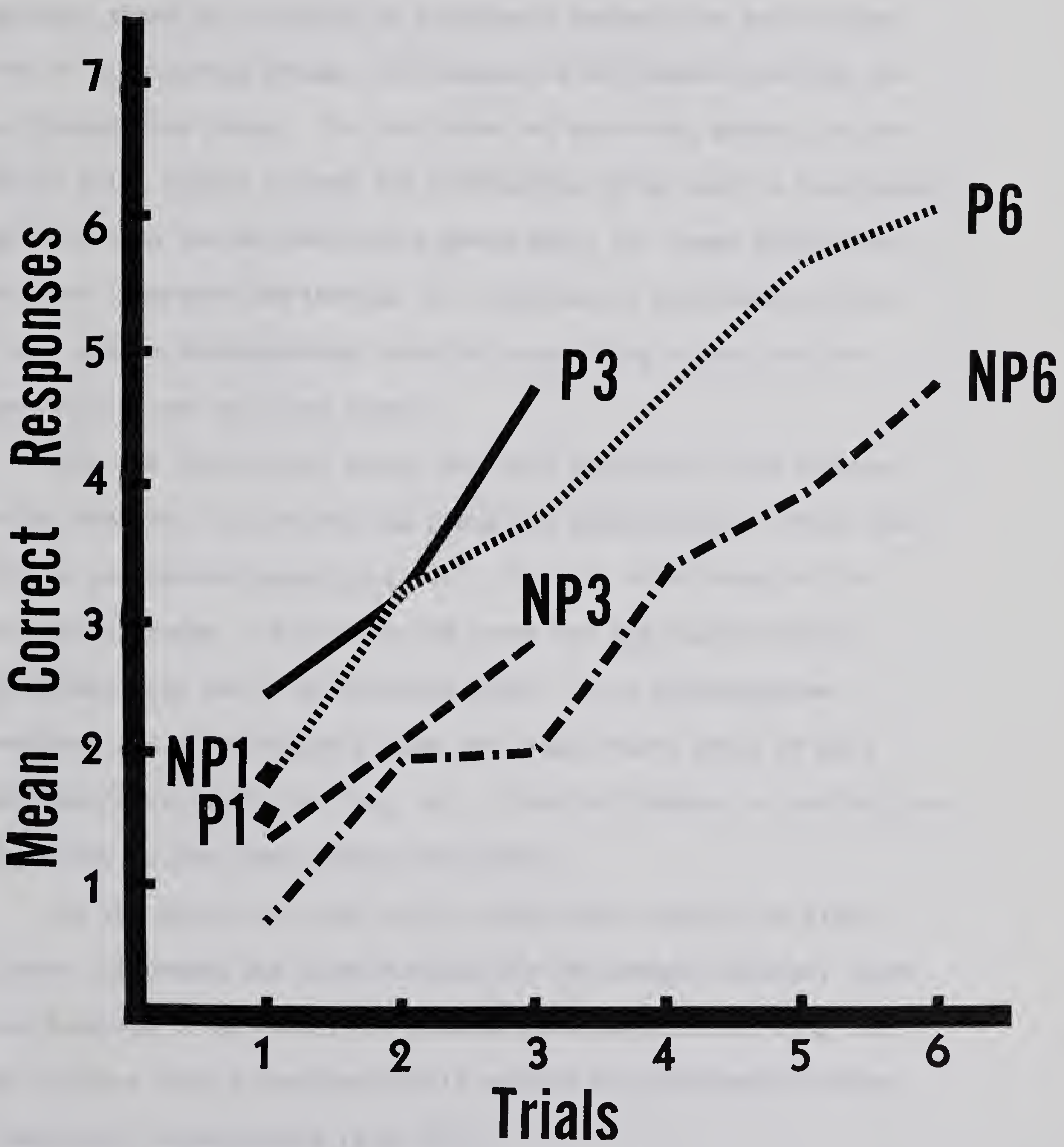


Figure 2. Mean Correct Responses on Each Paired-Associate Recall Trial for all the Groups of Experiment #1.

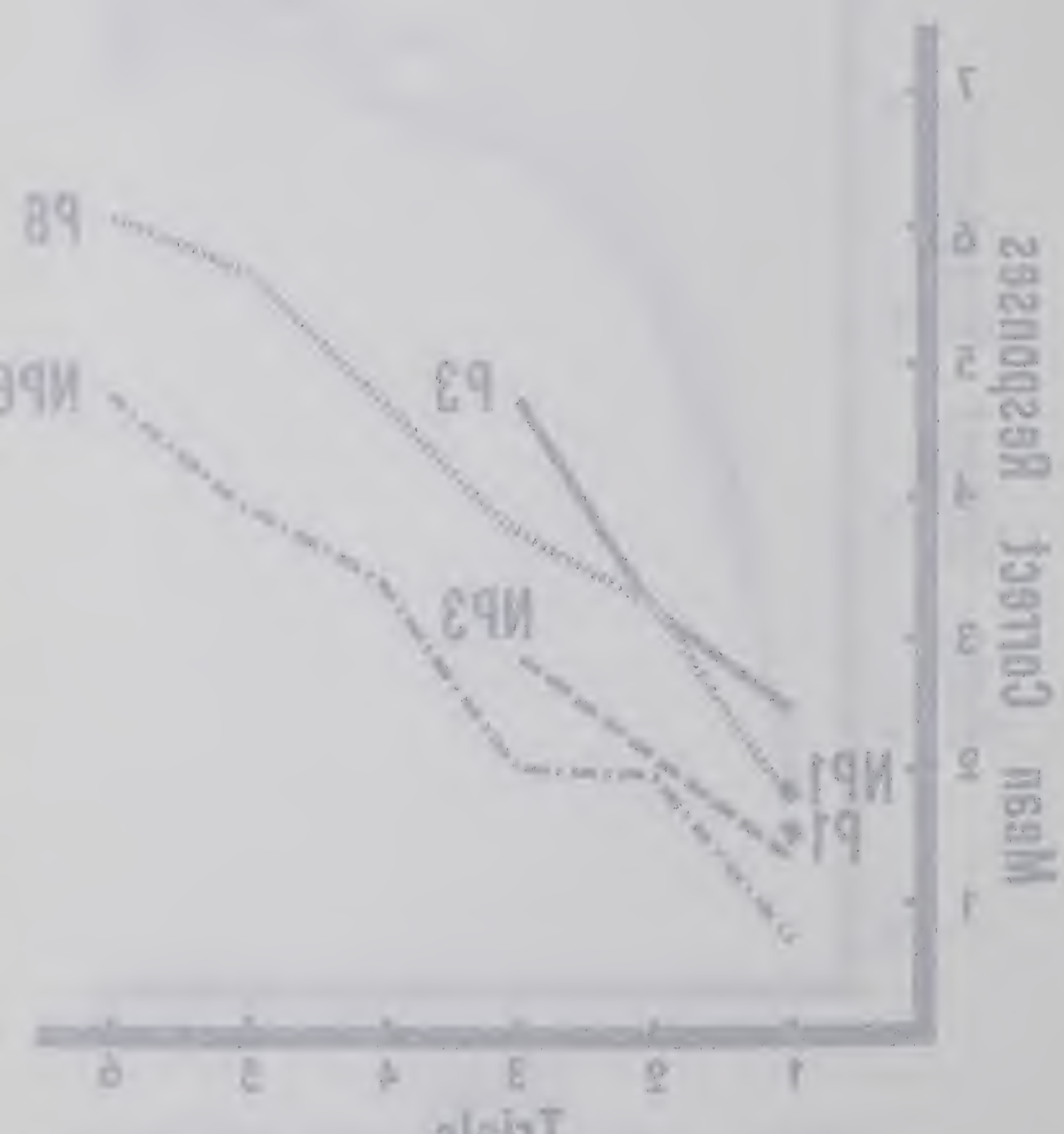


Figure 2. Mean Correct Responses in Each Paired-associ[illegible]

are given in Table 2, while the statistical comparisons of the means for the pretraining and no pretraining groups are given in Table 3.

It can be seen from Tables 2 and 3 that for the one-trial groups, there is virtually no difference between the pretraining and no pretraining groups, the negligible difference favoring the no pretraining group. For the three and six-trial groups, on the first trial, Figure 2 shows the pretraining group mean is considerably greater than the no pretraining group mean, but these differences are not important for testing the experimental hypothesis, since there are no corresponding associative-matching scores for the one-trial level of these groups.

For the three-trial groups for both final-trial and combined-trial measures the pretraining group was significantly better than the no pretraining group ($p < .01$). For the third trial of the six-trial groups, the pretraining group was not significantly different from the no pretraining group. With heterogeneous variance and a two-tailed $t$ test the significance level of this difference was quite low ($p < .20$). This difference is similarly not important to the experimental hypothesis.

At the six-trial level on the final-trial measure no significant difference was found between the two groups, however, there was a strong trend toward pretraining group superiority ($p < .10$). On the more stable combined-trials measure the difference reached statistical significance ($p < .05$).

TABLE 2

MEAN PAIRED-ASSOCIATE SCORES FOR EXPERIMENT #1

| | Trials in Group | | |
| --- | --- | --- | --- |
| | 1 | 3 | 6 |
| 1. Final-Trial Measure | | | |
| Pretraining Groups | 1.54 | 4.71 | 6.04 |
| No Pretraining Groups | 1.83 | 2.83 | 4.75 |
| 2. Combined-Trials Measure | | | |
| Pretraining Groups | 1.54 | 10.25 | 25.08 |
| No Pretraining Groups | 1.83 | 6.25 | 16.67 |

TABLE 3

COMPARISONS OF PAIRED-ASSOCIATE MEANS FOR PRETRAINING AND NO PRETRAINING GROUPS OF EXPERIMENT #1

| Comparison | Difference | *t* | Variance | p (two-tail) |
|---|---|---|---|---|
| 1. Final-Trial Measure | | | | |
| P1 - NP1 | -.29 | .64 | homogeneous | $<.60$ |
| P3 - NP3 | 1.88 | 2.98 | heterogeneous (P3 greater) | $<.01$ |
| P6 - NP6 | 1.29 | 1.84 | homogeneous | $<.10$ |
| 2. Combined-Trials Measure | | | | |
| P1 - NP1 | -.29 | .64 | homogeneous | $<.60$ |
| P3 - NP3 | 4.00 | 2.88 | heterogeneous (P3 greater) | $<.01$ |
| P6 - NP6 | 8.41 | 2.45 | heterogeneous (P6 greater) | $<.05$ |

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The results all point to the fact that the paired-associate recall score for any one trial is not very reliable as a measure of the paired-associate learning process. The measure of the sum of the scores over all trials, provides a more stable measure of paired-associate learning, since there is opportunity for the factors which may facilitate or hinder paired-associate recall on a single trial to be counterbalanced when several trials are considered.

Associative-Matching Test

The mean number of correct responses on the associative-matching test for each group is shown in Figure 3, and it is obvious there is only a small trend toward pretraining group superiority. This trend is an increasing function of the number of trials of paired-associate recall.

A 2 x 3 factorial analysis of variance was carried out with these scores and Table 4 is the summary table for this analysis. There is no significant difference between pretraining and no pretraining groups on the associative-matching scores ($p < .25$). However, the difference between groups divided according to number of paired-associate recall trials is highly significant ($p < .005$); this difference is to be expected and is not crucial to the experimental hypothesis. The pretraining x trials interaction coefficient was not calculated, since it is below one and not statistically significant.

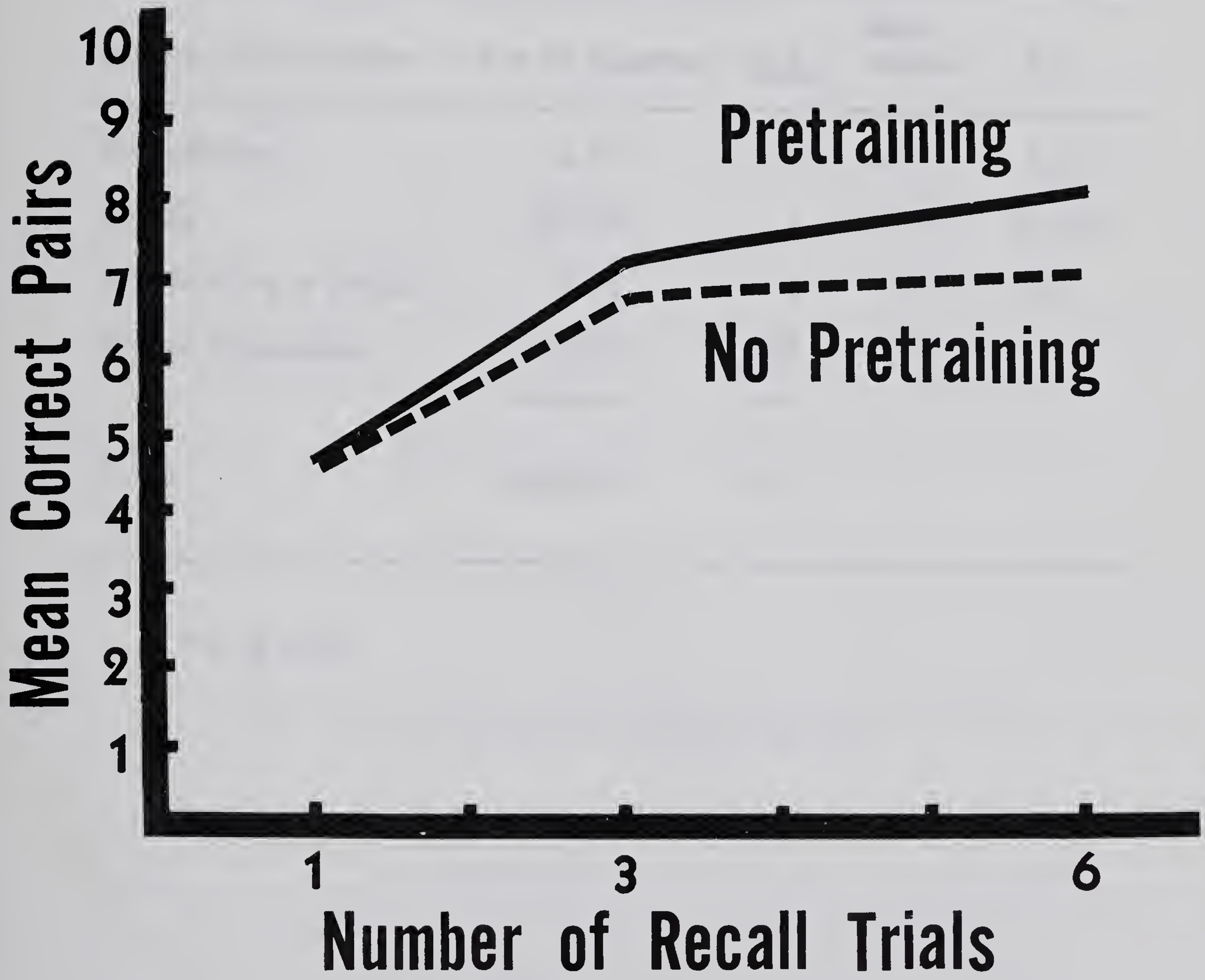


Figure 3. Mean Associative-Matching Scores.

TABLE 4

SUMMARY TABLE FOR THE ANALYSIS OF VARIANCE
OF ASSOCIATIVE-MATCHING SCORES

| Source of Variation | Sum of Squares | d.f. | Mean Square | F |
|---|---|---|---|---|
| Pretraining | 10.57 | 1 | 10.57 | 1.50 |
| Trials | 245.29 | 2 | 122.65 | 17.35* |
| Pretraining x Trials | 5.55 | 2 | 2.78 | $<1$ |
| Within Treatments | 975.03 | 138 | 7.07 | |
| Total | 1236.44 | 143 | | |

* $p < .005$

Selected statistical comparisons between pretraining and no pretraining groups are presented in Table 5. Statistically speaking, these comparisons are not justified in view of the lack of significance found in the analysis of variance. These comparisons were made only because they are of crucial experimental interest. A common variance estimate derived from the analysis of variance error term has been used for the comparisons (McNemar, 1962, p. 286).

The lack of a statistically significant difference between the pretraining and no pretraining groups is consistent with the independent stage hypothesis. There is a slight difference favoring the pretraining groups, and this is not consistent with the independent stage hypothesis. This slight difference will be discussed later.

TABLE 5

SELECTED COMPARISONS FROM THE ANALYSIS OF VARIANCE OF ASSOCIATIVE-MATCHING SCORES

| Comparison | Difference | $\underline{t}$ | p (two-tail) |
|---|---|---|---|
| P1 - NP1 | 4.64 - 4.54 = .09 | .12 | $>$ .90 |
| P3 - NP3 | 7.25 - 6.75 = .50 | .65 | $<$ .60 |
| P6 - NP6 | 8.13 - 7.08 = 1.05 | 1.36 | $<$ .20 |

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# CHAPTER 6

## PROCEDURE - EXPERIMENT #2

Experiment #2 is a variation of Experiment #1. Experiment #2 differs somewhat in method from the first and main experiment and it was carried out with the intention of answering a methodological criticism of Experiment #1. The main difference between the two experiments is the use of the written-recall test in Experiment #2 in place of the associative-matching test of Experiment #1. Briefly stated, the written-recall test was used to provide a check on the effect of pacing (i.e., having 2 sec. to learn and 2 sec. to respond with a response term in any one trial) on paired-associate recall scores. The associative-matching task was unpaced, while the paired-associate task was paced, therefore any difference between the two tests could be reflecting pacing factors instead of response availability.

In the written-recall test the response terms are not available to the S, only the stimulus terms; the only difference between the paired-associate test and the written-recall test is the pacing condition in the former and the lack of pacing in the latter. Therefore, any difference found between the pretraining and no pretraining groups in paired-associate recall would also be found in the written-recall test, *if* response availability or some factor other than pacing determined the pretraining group superiority. If, however, the effect of pacing on paired-associate recall scores is such that it causes the difference found between the pretraining

and no pretraining groups, then the absence of pacing in the written-recall test would cause the difference between the pretraining and no pretraining groups to disappear in the written-recall test. The relationship between pretraining and no pretraining groups in the written-recall test would thus be the same as in the associative-matching test.

Materials

The stimulus-response pairs are the same as those in the main experiment.

Subjects

For Experiment #2 82 Ss, 56 males and 26 females, served. All Ss were from the Introductory Psychology class, and the conditions for serving were the same as for Experiment #1. The two experimental conditions were run alternatively. No Ss were rejected.

General Design

There were two groups of 41 Ss each. One group received 10 trials of relevant response pretraining, while the other group received no response pretraining. Both groups received three paired-associate recall trials, and thus four trials of paired-associate learning. A written-recall test followed immediately.

Response Pretraining

For the response pretraining group the response terms were presented as in the main experiment.

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Paired-Associate Learning

Presentation of the paired-associate list was again the same as in the main experiment. Since only three recall trials were given to each group in this experiment, there were only four presentations of the pairs. These presentations were in the same order as for the three-trial groups of the main experiment. Only three trials of paired-associate recall were given in Experiment #2 because an analysis of the Experiment #1 data showed the difference between pretraining and no pretraining groups to be the most pronounced at the three-trial level ($p < .01$).

Written-Recall Test

When the S had completed his three recall trials, the experimenter read another short instruction and handed the S a written-recall test. The actual instruction appears in the Appendix. The written-recall test was a sheet of paper on which the trigrams were listed on the left, each followed by a blank space. No response terms were listed in the test. The Ss were required to write the appropriate response term opposite each trigram, but they were not required to fill in all the blanks. For this test Ss were allotted 3 min. Four different recall sheets were used. An equal number of Ss in each condition received each sheet. The stimulus terms on the written-recall sheets were in different scrambled orders from those orders used on any previous part of this experiment. The orders were the same as for the associative-matching test of Experiment #1.

<u>Large Number of Subjects in Experiment #2</u>

Originally it was intended to have 20 <u>S</u>s in each of the two groups. The data for these 40 <u>S</u>s were found to be very different from the data for the P3 and NP3 <u>S</u>s of Experiment #1. It was thought that the discrepant results were due to sampling error in the P3 <u>S</u>s of Experiment #2. Accordingly 42 more <u>S</u>s, 21 in each group, were immediately added, and the total <u>N</u> for Experiment #2 became 82. The results for these additional 42 <u>S</u>s were not very different from the results of the first 40 <u>S</u>s, although the results of these latter 42 <u>S</u>s more closely approximated those of Experiment #1. It was felt there was justification to deal with these two parts of Experiment #2 together. Some data and comparisons for the first 40 <u>S</u>s and for the last 42 <u>S</u>s will be presented separately in the Appendix.

## CHAPTER VII

## RESULTS - EXPERIMENT #2

### Response Pretraining

The mean scores for the 10 response-recall trials of the pretraining groups in Experiment #1 and #2 are given in Table 6. It is obvious from this table that the scores for the different groups do not differ by large amounts. At the commencement of paired-associate learning, then, all the groups seemed to have learned the response terms to an equal degree. Furthermore, the groups, as groups, seemed to be of the same ability, at least insofar as this type of response learning is a measure of ability.

### Paired-Associate Learning

The paired-associate recall scores for the three trials are depicted in Figure 4. It can be seen that the small difference between the pretraining and no pretraining groups exhibited on the first and second trials virtually disappears on the third trial.

The mean recall scores for the two groups (final-trial and combined-trial measures) are presented in Table 7. Also presented in Table 7 are the mean recall scores for the three-trial groups of Experiment #1. The statistical comparisons between the pretraining and no pretraining groups for Experiments #1 and #2 are presented in Table 8.

The mean paired-associate recall score for the P3 group is not significantly different from that for the NP3 group for either

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TABLE 6

MEAN SCORES ON RESPONSE-RECALL TRIALS
FOR THE PRETRAINING GROUPS OF EXPERIMENTS #1 AND #2

| Response-Recall Trials | Experiment #1 P1 | Experiment #1 P3 | Experiment #1 P6 | Experiment #2 P3 |
|---|---|---|---|---|
| 1 | 5.63 | 5.71 | 5.88 | 5.76 |
| 2 | 7.67 | 7.25 | 7.13 | 7.51 |
| 3 | 8.42 | 8.17 | 8.08 | 8.27 |
| 4 | 9.00 | 8.67 | 8.46 | 8.76 |
| 5 | 8.96 | 8.83 | 8.83 | 8.78 |
| 6 | 9.29 | 8.96 | 8.83 | 9.22 |
| 7 | 9.38 | 9.04 | 9.00 | 9.24 |
| 8 | 9.54 | 9.58 | 9.29 | 9.44 |
| 9 | 9.71 | 9.50 | 9.38 | 9.68 |
| 10 | 9.75 | 9.54 | 9.38 | 9.73 |

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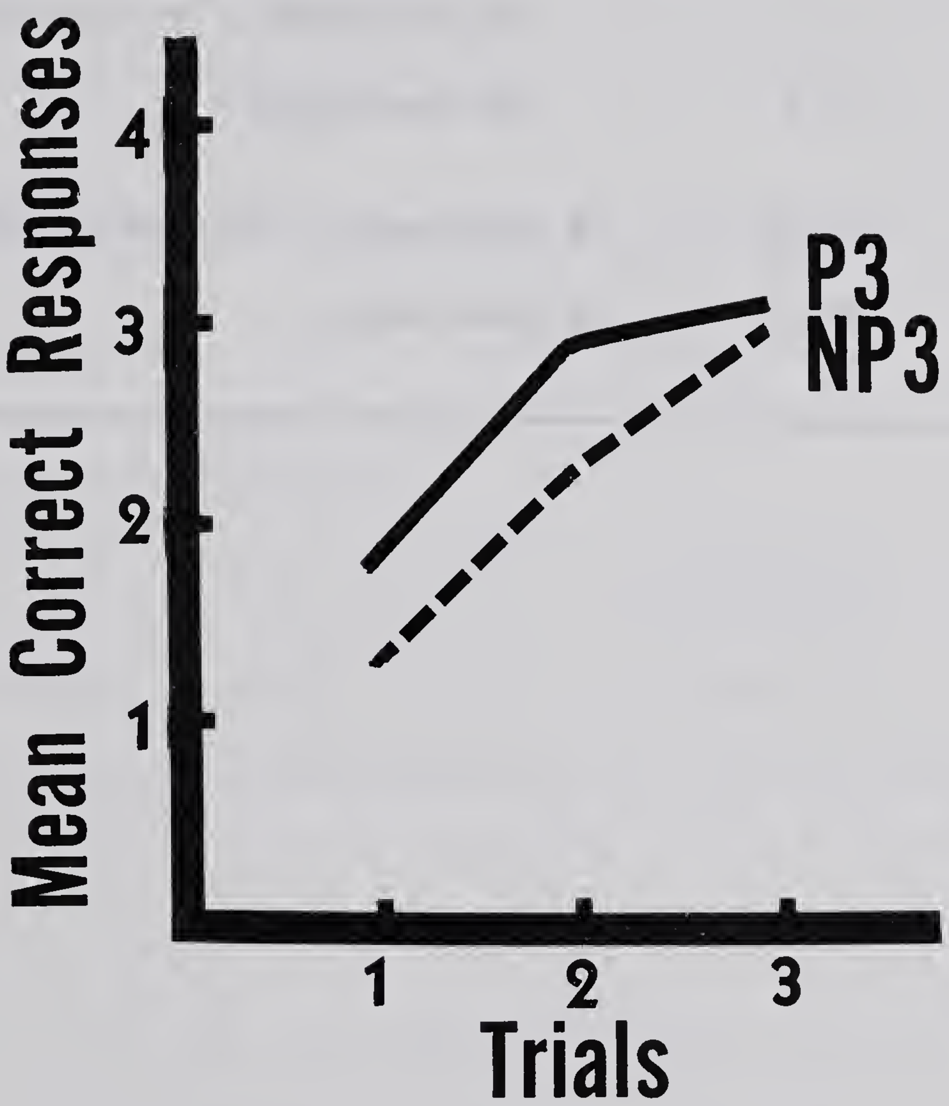


Figure 4. Mean Correct Responses on Each Paired-Associate Recall Trial for the Groups of Experiment #2.

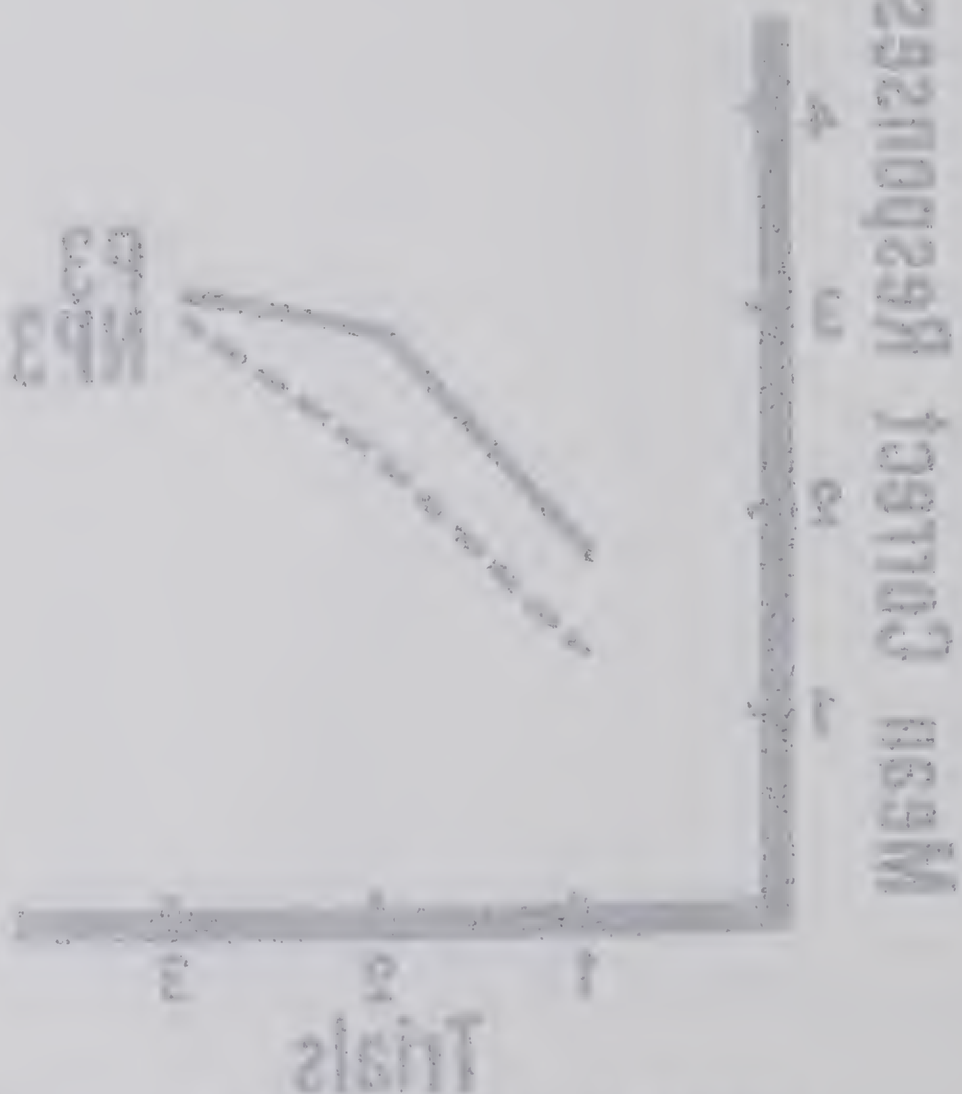


Figure 4. Mean Correct Responses on each Paired-associate Recall Trial for the Groups of Experiment #2.

TABLE 7

MEAN PAIRED-ASSOCIATE RECALL SCORES FOR THE THREE-TRIAL GROUPS OF EXPERIMENTS #1 AND #2

| | P3 | NP3 |
|---|---|---|
| Final-Trial Measure - Experiment #1 | 4.71 | 2.83 |
| - Experiment #2 | 3.05 | 2.95 |
| Combined-Trials Measure - Experiment #1 | 10.25 | 6.25 |
| - Experiment #2 | 7.68 | 6.39 |

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TABLE 8

COMPARISONS OF PAIRED-ASSOCIATE RECALL MEANS FOR THE THREE-TRIAL GROUPS OF EXPERIMENTS #1 AND #2

| Comparison (P3 - NP3) | Difference | *t* | Variance | p (two-tail) |
|---|---|---|---|---|
| 1. Final-Trials Measure | | | | |
| Experiment #1 | 1.88 | 2.98 | heterogeneous (P3 greater) | $<.01$ |
| Experiment #2 | .10 | .19 | homogeneous | $<.90$ |
| 2. Combined-Trials Measure | | | | |
| Experiment #1 | 4.00 | 2.88 | heterogeneous (P3 greater) | $<.01$ |
| Experiment #2 | 1.29 | 1.01 | homogeneous | $<.40$ |

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measure in Experiment #2 ($p < .90$ for the final-trial measure, and $p < .40$ for the combined-trials measure). For both paired-associate score measures the P3 group in Experiment #2 is considerably below that of Experiment #1, while the NP3 groups are the same for both experiments (Table 7). Though the P3 group scores of Experiment #2 are generally poor, as Figure 4 and the combined-trials measure of Table 7 show, the final-trial score is especially unusual. This final-trial score is a large cause of the lack of difference between the P3 and NP3 groups in this experiment, and it is probably justifiable to conclude this final trial was a "fluke". The possibility of sampling error effecting the difference between the P3 groups of the two experiments is not ruled out, however.

Written-Recall Test

Since there was no difference in paired-associate recall scores in Experiment #2, no difference could be expected between the pretraining and no pretraining groups in the written-recall test either. The effect of pacing cannot be ascertained clearly from this written-recall test. The mean written-recall score for each group and the statistical comparison between the P3 and NP3 mean scores are presented in Table 9.

The difference between the two groups is not significant. However, there is a trend in the P3 group direction ($p < .20$). One additional learning trial took place after the _S_ recalled the responses on the last paired-associate recall trial and the written-recall test is to this extent independent of the third

TABLE 9

MEAN WRITTEN-RECALL SCORES AND THEIR COMPARISON

| P3 | NP3 | Difference (P3 - NP3) | $t$ | Variance | p (two-tail) |
|---|---|---|---|---|---|
| 5.63 | 4.78 | .85 | 1.35 | homogeneous | $<.20$ |

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paired-associate recall trial. The increased superiority of the P3 group in the written-recall test as compared to its negligible superiority on the last paired-associate recall trial adds credence to the notion that the last paired-associate recall trial was a "fluke". Furthermore the small difference which reappears in the written-recall test is consistent with the hypothesis that pre-training group superiority is not due to pacing.

The effects of pacing cannot be ascertained unequivocally from the written-recall test. However, some additional evidence for the effects of "availability" can be obtained from a comparison of the written-recall and associative-matching scores for the NP3 groups with the final-trial paired-associate recall score for each group. The differences are presented in Table 10.

The difference between the associative-matching score and the final-trial paired-associate recall score is greater than the difference between the written-recall score and the final-trial paired-associate recall score. The greater difference between the paired-associate score and the associative-matching score occurs despite the fact that pacing was not required for either the associative-matching or the written-recall tests. Since these comparisons involve only the no pretraining groups, and since the groups' experimental treatments were exactly the same up to the time of the associative-matching and written-recall tests, the greater difference between the paired-associate and associative-matching scores can only be due to the presence of the response terms in the associative-matching test.

TABLE 10

COMPARISONS OF THE ASSOCIATIVE-MATCHING AND WRITTEN-RECALL SCORES WITH THE FINAL-TRIAL PAIRED-ASSOCIATE RECALL SCORE

| Experiment #1 | P3 | NP3 | Experiment #2 | P3 | NP3 |
|---|---|---|---|---|---|
| Associative-Matching | 7.25 | 6.75 | Written-Recall | 5.63 | 4.78 |
| Paired-Associate | 4.71 | 2.83 | Paired-Associate | 3.05 | 2.95 |
| Difference | 2.54 | 3.92 | | 2.58 | 1.83 |

The greater difference is due to the presence of the responses at the time of recall.

For the pretraining groups the difference between the associative-matching score and the final-trial paired-associate recall score is the same as the difference between the written-recall score and the final-trial paired-associate recall score. The response terms are available to the pretraining groups and the presence of the response terms in the associative-matching test does not have any specific facilitating effect.

Additional Analyses

Psychology Grades and Paired-Associate Recall Scores. The hypothesis was entertained that perhaps the reason for the discrepant data of the P3 group of Experiment #2 was that, due to sampling error, Ss of this group were generally of lower learning ability than the Ss of the other groups. The scores on the response-recall trials for Experiments #1 and #2 argue against this hypothesis, but further to test this hypothesis the Introductory Psychology marks for the November and January examinations were obtained and used as a measure of Ss' learning ability.

In *t* tests done, it was shown that statistically speaking the mean Introductory Psychology marks for the Experiment #2 P3 group was significantly lower than that for the NP3 group ($p < .05$). It seemed possible that, due to sampling error, the Ss in the P3 group of Experiment #2 were of lower ability than those in the NP3 group.

To test this hypothesis further, a treatments X mark-levels analysis of variance of both the Experiment #2 paired-associate recall scores (combined-trials measure) and the written-recall scores was carried out. No significant differences for paired-associate recall scores or for written-recall scores were found between groups at different Introductory Psychology mark levels ($F < 1$). Scattergrams showed there was a negligible correlation between Introductory Psychology marks and paired-associate and written-recall scores. These results can be considered evidence that the statistically significant difference between P3 and NP3 marks does not indicate the cause of the lack of difference between the two groups in Experiment #2. Sampling error in ability of Ss as it is refelcted in Introductory Psychology marks has been ruled out as a cause of the discrepant results of Experiment #2. This does not rule out sampling error.

Further analysis showed that the difference between the P3 groups of the two experiments was due to the scores made by the males. No clear relationship between Introductory Psychology marks and paired-associate recall scores could be found. Any sampling error effecting the difference between the two experiments occurred among the male Ss of the P3 groups.

Practiced Versus Non-Practiced Subjects. A few of the Ss were practiced. Since the number of practiced Ss does not exceed four in any group and since the differences between the total Ss and the practiced Ss in mean paired-associate, associative-matching and written-recall scores are not great, no further discussion is merited in this paper.

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# CHAPTER VIII

## DISCUSSION

The main findings of Experiment #1 were:

1. In paired-associate recall for the three and six-trial groups there were significant differences favoring the pretraining groups; for the one-trial group there was a difference not statistically significant favoring the no pretraining group.

2. No statistically significant differences were found between pretraining and no pretraining groups on the associative-matching test.

The lack of statistical significance of the differences in the associative-matching scores is considered evidence that response availability in the response-recall sense is not necessary for associative learning; the independent stage hypothesis rests on the tacit acceptance of the null hypothesis, which is rather insensitive. However, in view of the large number of Ss (24) in each group, this test has some power; the probability of a type II error is low.

The main findings of Experiment #2 were:

1. There was virtually no difference between the pretraining and no pretraining groups in paired-associate recall scores for the three-trial groups of this experiment.

2. There was a difference not significant statistically favoring the pretraining group in the written-recall scores.

The negligible difference between the pretraining and no pretraining groups on the third trial of paired-associate recall for Experiment #2 has been attributed to the fact that the third-trial score for the P3 group is a "fluke". Evidence that the third-trial score is a "fluke" is found in the written-recall test when the difference between the pretraining and no pretraining groups, though not significant, reappears.

In Experiment #2, because there were no significant differences between pretraining and no pretraining groups in paired-associate recall, the results of the written-recall test could not indicate directly the effect of pacing. There is, however, indirect evidence that the effect pacing might have had on paired-associate scores, and the effect the lack of pacing might have had on the associative-matching scores are not substantial. The pretraining-no pretraining difference would not be expected to reappear at all in the written-recall test, if pacing were the only factor favoring the pretraining groups in paired-associate recall. Then, in the written-recall test the reappearance of the difference suggests, not only that the third-trial paired-associate score was a "fluke", but also that it is response availability which at least in part causes the pretraining groups to be superior in paired-associate recall. Pacing and other factors may also contribute to the pretraining group superiority. The evidence for the conclusion in favor of "availability" or some other factor rather than pacing alone is not very strong, since it is somewhat indirect and statistically insignificant. More research on the effects of pacing is needed.

There is some evidence that a large sampling error occurring in the males of the P3 groups has effected the discrepant results of the two experiments. It was impossible to locate the factors influencing the scores of the P3 groups' males. Suffice it to say that sampling error has contributed to the difference in results between the two experiments.

There are further complications in considering the associative-matching test scores as evidence that the response-learning and associative stages are independent. One complication is that there are slight differences between the pretraining and no pretraining groups on the associative-matching test scores, though the differences are not statistically significant. It is not clear why these differences occur. Perhaps the relationship between "availability" and associative learning cannot be explained as simply as has been postulated in this thesis. It may be that, while response availability is not necessary for associative learning to take place, it does facilitate associative learning somewhat. For example, if the response is available before associative learning takes place, the associations formed may be more stable. An "available" response term has been differentiated from the "pool of vocabulary". Such differentiation would be expected to reduce the amount of interference from response terms not in the list. The pretraining group superiority in the associative-matching test gives reason to speculate that the relationship between the two stages in verbal learning is more complicated than visualized in this thesis.

It is a possible criticism of the associative-matching test that it is an inappropriate measure of associative learning. There are a variety of reasons which may be cited for this inappropriateness. An important one is insensitivity because of having the responses "right there, in front of one". The specific effect of this aspect of any recognition test, as opposed to having the responses "in one's head" as in the recall test, is not known. Another reason the associative-matching test can be criticized is that it is possible in the test to guess. This factor might affect the pretraining and no pretraining groups differently. If the associations were more stable for the pretraining groups, the pretraining groups' Ss would be able to guess more accurately than the no pretraining groups' Ss; the slight superiority of the pretraining group scores in the associative-matching test may be explainable by this guessing factor.

There is some additional support for the independent hypothesis with regard to availability obtained from Table 10. For the P3 groups the difference between the associative-matching score and the third-trial paired-associate recall score is the same as the difference between the written-recall score and the third-trial paired-associate recall score. For the NP3 groups the difference between the associative-matching score and the third-trial paired-associate recall score is greater than the difference between the written-recall score and the third-trial paired-associate recall score. These findings cannot be attributed to the effects of pacing or to the effects of any factors other than presence of the response terms, since the comparisons involve

either pretraining groups alone or no pretraining groups alone. The experimental treatment for the pretraining groups was identical up to the time of the associative-matching and written-recall tests, as was the experimental treatment for the no pretraining groups. For the no pretraining groups the greater difference between paired-associate and associative-matching scores can only be due to the presence of the response terms in the associative-matching test. The greater difference is predicted if response availability facilitates recall, but not the formation of associations. Response availability could also facilitate the formation of associations, but this comparison making use of only no pretraining groups is not relevant to that question. For the pretraining groups, since the response terms are already available, the presence of the response terms in the associative-matching test would not be expected to have any specific facilitating effect. It may be concluded from the comparisons of Table 10 that the pretraining group superiority in paired-associate recall is due, at least in part, to the availability of the response term at the time of recall. The independent stage hypothesis with regard to the effect of availability receives some support from these comparisons.

Several additional analyses were carried out in an attempt to find more supporting data for the hypothesis. For various reasons these analyses were biased. The clear interpretation of their results was prohibited due to complicating factors which might have been reflected in the results; these analyses and their

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results were accordingly not presented. The best and clearest evidence supporting the experimental hypothesis rests on the main analyses presented above.

Though the results of this thesis research are not unequivocal, it seems obvious that the results of the two experiments offer good reason to reconsider the Underwood, and Schulz (1960) position concerning the necessity of response-availability for associative learning, and to consider instead the alternative hypothesis that response-learning and the formation of associations in paired-associate learning are independent processes.

Further research is necessary to definitely answer the question of the effect of response availability on associative learning. Such problems as the effect of pacing, and the suitability of the measure of associative learning will have to be considered in further research. There is a possibility that the relationship between the two stages is not as simple as it was considered in this thesis. Ways of isolating the factors involved in this complex verbal learning situation have yet to be found.

## References


Archer, E. J. A re-evaluation of the meaningfulness of all possible CVC trigrams, Psychol. Monog., 1960, 74, 10 #497.

Archer, E. J. Supplementary Report: Familiarity or low validity? J. exp. Psychol., 1961, 62, 207-208.

Bousfield, W. A., & Barclay, W. D. The relationship between order and frequency of occurrence of restricted associated responses, J. exp. Psychol., 1950, 40, 643-647.

Bousfield, W. A., & Cohen, B. H. The occurrence of clustering in the recall of randomly arranged words of different frequencies of usage, J. gen. Psychol., 1955, 52, 83-95.

Bousfield, W. A., Cohen, B. H., & Whitmarsh, G. A. Associative clustering in the recall of words of different taxonomic frequencies of occurrence, Psychol. Rep., 1958, 4, 39-44.

Cieutat, V. J., Stockwell, F. E., & Noble, C. E. The interaction of ability and amount of practice with stimulus and response meaningfulness (m, m') in paired-associate learning, J. exp. Psychol., 1958, 56, 193-202.

Cofer, C. N., & Musgrave, Barbara S. Verbal behavior and learning: problems and processes, McGraw-Hill Book Co. Inc., 1963.

Cohen, B. H., Bousfield, W. A., & Whitmarsh, G. A. Cultural norms of verbal items in forty-three categories, Technical Report No. 22, ONR Contract Nonr_631 (00), Univer. of Conn., 1957.

Cromwell, R. L. Factors in the serial recall of names of acquaintances, J. abnorm. soc. Psychol., 1956, 53, 63-67.

Edwards, A. L. Experimental design in psychological research, Holt, Rinehart, and Winston, 1963.

Epstein, W. The effect of stimulus and response meaningfulness when response availability is equated, J. verb. learning and verb. behavior, 1963, 2, 242-249.

Epstein, W., & Streib, R. The effect of stimulus meaningfulness and response meaningfulness in the absence of response learning, J. verb. learning and verb. behavior, 1962, 1, 105-108.

Haagen, C. H. Synonimity, vividness, familiarity, and association value ratings of 400 pairs of common adjectives, J. Psychol., 1949, 27, 453-463.

Hall, J. F. Learning as a function of word-frequency, Amer. J. Psychol., 1954, 67, 138-140.

Horowitz, L. M. Associative matching and intralist similarity, Psychol. Rep., 1962, 10, 751-757.

Hovland, C. I., & Kurtz, K. H. Experimental studies in rote-learning theory: X. Prelearning syllable familiarization and the length-difficulty relationship, J. exp. Psychol., 1952, 44, 31-39.

Howes, D. On the relationship between the probability of a word as an association and in general linguistic usage, J. abnorm. soc. Psychol., 1957, 54, 75-85.

Jacobs, A. Formation of new associations to words selected on the basis of reaction-time-GSR combinations, J. abnorm. soc. Psychol., 1955, 51, 371-377.

Johnson, D. M. Word-association and word-frequency, Amer. J. Psychol., 1956, 69, 125-126.

Kimble, G. A., & Dufort, R. H. Meaningfulness and isolation as factors in verbal learning, J. exp. Psychol., 1955, 50, 361-368.

L'Abate, L. Manifest anxiety and the learning of syllables with different associative values, Amer. J. Psychol., 1959, 72, 107-110.

McNemar, Q. Psychological statistics, 3rd ed., New York, Wiley, 1962.

Noble, C. E. The role of stimulus meaning (m) in serial verbal learning, J. exp. Psychol., 1952, 43, 437-446.

Noble, C. E. The familiarity-frequency relationship, J. exp. Psychol., 1954, 47, 13-16.

Noble, C. E. The effect of familiarization upon serial verbal learning, J. exp. Psychol., 1955, 49, 333-338.

Pratt, F. Secret and urgent, Indianapolis: Bobbs-Merill, 1939.

Riley, D. A., & Phillips, L. W. The effects of syllable familiarization on rote learning, association value, and reminiscence, J. exp. Psychol., 1959, 57, 372-379.

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Runquist, W. N., & English, Judith M. Response pretraining and the availability hypothesis, Psychon. Sci., 1964, 1, 121-122.

Runquist, W. N., & Freeman, M. Roles of association value and syllable familiarization in verbal-discrimination learning, J. exp. Psychol., 1960, 59, 396-401.

Saltz, E. Response pretraining: differentiation or availability? J. exp. Psychol., 1961, 62, 583-587.

Schulz, R. W., & Lovelace, E. A. Meaningfulness and the associative phase of paired-associate learning: A methodological consideration, Psychon. Sci., 1964, 1, 37-38.

Sheffield, F. D. The role of meaningfulness of stimulus and response in verbal learning, Ph.D. dissertation, Yale Univer., 1946.

Thorndike, E. L., & Lorge, I. The teacher's word book of 30,000 words, New York: Bur. of Publ. Teacher's Coll., Columbia Univer., 1944.

Underwood, B. J., Runquist, W. N., & Schulz, R. W. Response learning in paired-associate lists as a function of intralist similarity, J. exp. Psychol., 1959, 58, 70-78.

Underwood, B. J., & Schulz, R. W. Meaningfulness and verbal learning, Chicago: Lippincott, 1960.

Waters, R. H. The law of acquaintance, J. exp. Psychol., 1939, 24, 180-191.

# APPENDICES

# APPENDIX 1

## Learning Materials for Experiments #1 and #2

| | |
|---|---|
| SOQ - Alert | HUZ - Bashful |
| ZIM - Regal | TOF - Clumsy |
| GEY - Vacant | LEH - Obscure |
| JIS - Guarded | CYR - Lifeless |
| PAJ - Weeping | DAK - Shocking |

# APPENDIX 2

## Instructions Given to Subjects

<u>Response Pretraining Instructions</u>

"On the screen in front of you will appear a series of ten English words, shown one at a time. When each word appears, you are to pronounce it out loud. Try to learn as many of the words as possible."

Upon presentation of the paper with the ten blank spaces, further instructions were given: "Please write down all the words you can remember in any order in which they occur to you."

<u>Paired-Associate Instructions</u>

"This is a learning experiment in which you will learn to associate nonsense words with some common words. It is very important that you follow the instructions to the best of your ability, as the interpretation of the results may be affected if you do not.

The list will consist of pairs of items which will be presented in the window in front of you. When we begin, the nonsense word will always appear in the window alone. Then, after a short time, the word will appear next to it. Your task is to associate or connect the word with the nonsense word, so that you will be able to say out loud the word while the nonsense word is in the window alone, that is <u>before</u> the word appears on the right.

Since the order in which the pairs follow each other will not always be the same, you must learn these pairs and not in the particular order in which the pairs follow each other.

When we start, we will go through the list once so that you can study the list and try to make associations between the members of the pairs. After we have gone through the pairs once, a blank space, like the one now in the window, will appear. The apperance of the blank means that we are starting another trial, in this case the second trial. It is on the second trial, that, when the nonsense word appears, you must begin trying to say the word that goes with it before it appears in the window. We will then continue to go through the list while you attempt to anticipate the second members of the pairs before they appear in the window. You will continue through the list, trial after trial, until I stop you.

Always try to anticipate the word just after the nonsense word has appeared. If you are able to say the word before it appears, I will count it as correct; on the other hand, if you say nothing or say the word <u>after</u> it appears, I will count it as incorrect.

Always try to get as many of the pairs correct as you can on each trial. You should try to do the best that you can on each trial, even though you may have gotten them all correct on some of the preceding trials. If you are having trouble anticipating some of the words or are giving some incorrectly, try not to let this

discourage you or prevent you from doing the best that you can. We have found that most students find this type of learning a little more difficult than they had at first thought it would be."

Associative-Matching Instructions (Experiment #1)

"On this sheet of paper, all the nonsense words are written on the left, and all the English words on the right. I want you to write the English word next to the nonsense word with which it has been paired. Please fill in all the blanks."

Written-Recall Instructions (Experiment #2)

"On this sheet of paper are written all the nonsense words you have seen. I want you to write the English word next to the nonsense word with which it has been paired."

# APPENDIX 3

## Raw Data

### Experiment #1 - P1

| Response-Recall 10 trials | Paired-Associate Trial 1 | Associative-Matching | Male or Female |
|---|---|---|---|
| * 68 | 2 | 8 | F |
| * 95 | 2 | 8 | F |
| * 85 | 0 | 1 | F |
| 88 | 1 | 5 | M |
| 84 | 1 | 3 | M |
| 96 | 4 | 6 | F |
| * 95 | 0 | 1 | F |
| * 83 | 1 | 2 | F |
| * 92 | 4 | 7 | F |
| * 88 | 0 | 6 | M |
| * 95 | 3 | 5 | F |
| 92 | 1 | 2 | M |
| 96 | 2 | 5 | F |
| 92 | 3 | 7 | M |
| 82 | 0 | 3 | M |
| 74 | 1 | 4 | M |
| 95 | 3 | 6 | F |
| 93 | 2 | 8 | F |
| 89 | 0 | 3 | M |
| 93 | 5 | 7 | M |
| 73 | 1 | 2 | F |
| 87 | 0 | 4 | M |
| 78 | 1 | 5 | M |
| 83 | 0 | 3 | M |

* The asterisk indicates that there were some procedural inconsistencies in testing the S. These Ss' results were not found to be different from the results of the Ss tested under consistent procedural conditions, and the two groups' results have been combined.

Experiment #1 - NP1

| Paired-Associate Trial 1 | Associative-Matching | Male or Female |
|---|---|---|
| 1 | 2 | M |
| 2 | 4 | F |
| 1 | 2 | F |
| * 2 | 5 | M |
| * 3 | 3 | F |
| * 1 | 5 | F |
| * 1 | 2 | M |
| 2 | 7 | M |
| * 0 | 4 | F |
| * 0 | 3 | F |
| * 1 | 3 | M |
| * 1 | 7 | M |
| * 1 | 1 | M |
| * 3 | 10 | F |
| 1 | 1 | M |
| 1 | 3 | F |
| 3 | 6 | F |
| 4 | 10 | M |
| 7 | 10 | F |
| 5 | 10 | F |
| 1 | 2 | M |
| 0 | 2 | M |
| 2 | 2 | F |
| 1 | 5 | F |

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Experiment #1 - P3

| Response-Recall 10 trials | Paried-Associate Trial 1 | Trial 2 | Trial 3 | Associative-Matching | Male or Female |
|---|---|---|---|---|---|
| * 86 | 4 | 7 | 8 | 10 | M |
| * 85 | 1 | 1 | 2 | 1 | F |
| 82 | 2 | 1 | 2 | 4 | F |
| * 83 | 2 | 1 | 3 | 6 | M |
| * 75 | 0 | 0 | 1 | 1 | M |
| * 92 | 6 | 8 | 9 | 10 | M |
| * 94 | 2 | 3 | 5 | 8 | M |
| * 78 | 3 | 7 | 8 | 10 | M |
| 89 | 1 | 3 | 3 | 10 | F |
| * 97 | 5 | 5 | 7 | 10 | F |
| 93 | 3 | 6 | 7 | 10 | F |
| * 71 | 4 | 3 | 3 | 8 | M |
| * 77 | 2 | 3 | 6 | 8 | M |
| 77 | 3 | 2 | 5 | 9 | M |
| 90 | 4 | 3 | 3 | 8 | F |
| 73 | 2 | 2 | 4 | 5 | M |
| 95 | 1 | 0 | 8 | 10 | F |
| 73 | 1 | 1 | 1 | 3 | M |
| 81 | 1 | 1 | 3 | 6 | F |
| 87 | 2 | 4 | 8 | 8 | M |
| 96 | 1 | 1 | 2 | 5 | F |
| 92 | 4 | 6 | 7 | 10 | F |
| 84 | 1 | 3 | 3 | 7 | M |
| 96 | 3 | 4 | 5 | 7 | F |

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Experiment #1 - NP3

| Paired-Associate Trial 1 | Trial 2 | Trial 3 | Associative-Matching | Male or Female |
|---|---|---|---|---|
| * 1 | 2 | 3 | 6 | F |
| 3 | 2 | 4 | 8 | F |
| * 2 | 3 | 4 | 10 | F |
| 4 | 3 | 2 | 9 | F |
| * 0 | 1 | 2 | 3 | M |
| * 0 | 1 | 0 | 4 | M |
| * 1 | 2 | 4 | 8 | F |
| * 3 | 5 | 5 | 10 | F |
| * 0 | 0 | 1 | 4 | M |
| * 1 | 2 | 5 | 10 | M |
| 1 | 2 | 2 | 4 | M |
| * 2 | 3 | 4 | 10 | F |
| * 2 | 2 | 1 | 10 | M |
| 0 | 1 | 2 | 5 | M |
| 1 | 0 | 3 | 4 | F |
| 1 | 3 | 6 | 6 | M |
| 2 | 4 | 4 | 10 | M |
| 3 | 5 | 6 | 10 | F |
| 1 | 1 | 1 | 6 | M |
| 0 | 1 | 0 | 4 | M |
| 1 | 1 | 1 | 4 | M |
| 2 | 2 | 1 | 6 | M |
| 1 | 2 | 3 | 5 | M |
| 0 | 2 | 4 | 6 | M |

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Experiment #1 - P6

| Response-Recall 10 trials | Trial 1 | Trial 2 | Paired-Associate Trial 3 | Trial 4 | Trial 5 | Trial 6 | Associative-Matching | Male or Female |
|---|---|---|---|---|---|---|---|---|
| * 74 | 1 | 1 | 5 | 4 | 4 | 8 | 10 | F |
| * 80 | 1 | 5 | 5 | 5 | 9 | 8 | 10 | M |
| * 79 | 1 | 4 | 3 | 5 | 4 | 2 | 5 | M |
| * 91 | 0 | 2 | 1 | 3 | 3 | 4 | 6 | F |
| * 94 | 6 | 8 | 8 | 9 | 10 | 10 | 10 | F |
| * 95 | 1 | 2 | 3 | 8 | 6 | 8 | 10 | F |
| * 82 | 1 | 2 | 2 | 2 | 3 | 2 | 3 | M |
| * 81 | 1 | 2 | 1 | 2 | 5 | 6 | 10 | F |
| * 68 | 1 | 0 | 0 | 2 | 2 | 4 | 3 | M |
| * 97 | 6 | 7 | 9 | 9 | 9 | 9 | 10 | F |
| * 70 | 3 | 6 | 4 | 6 | 6 | 7 | 10 | F |
| * 90 | 4 | 3 | 6 | 7 | 7 | 7 | 10 | F |
| 84 | 4 | 5 | 7 | 7 | 9 | 9 | 10 | M |
| 75 | 1 | 2 | 2 | 2 | 3 | 3 | 5 | M |
| 84 | 1 | 1 | 2 | 4 | 9 | 6 | 10 | M |
| 94 | 3 | 4 | 4 | 5 | 8 | 7 | 10 | F |
| 74 | 0 | 1 | 0 | 1 | 1 | 2 | 10 | M |
| 90 | 2 | 4 | 4 | 8 | 8 | 9 | 10 | F |
| 83 | 1 | 4 | 5 | 6 | 9 | 9 | 10 | F |
| 93 | 1 | 2 | 2 | 2 | 2 | 4 | 10 | F |
| 76 | 0 | 4 | 5 | 4 | 5 | 6 | 8 | F |
| 95 | 4 | 6 | 9 | 9 | 10 | 9 | 10 | F |
| 80 | 0 | 1 | 0 | 2 | 2 | 2 | 2 | M |
| 93 | 0 | 0 | 2 | 1 | 2 | 4 | 3 | F |

Experiment #1 - NP6

| Paired-Associate Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 | Trial 6 | Associative-Matching | Male or Female |
|---|---|---|---|---|---|---|---|
| * 2 | 4 | 5 | 8 | 8 | 8 | 10 | F |
| 0 | 0 | 1 | 5 | 4 | 4 | 10 | F |
| * 1 | 0 | 0 | 0 | 1 | 3 | 5 | M |
| * 0 | 1 | 1 | 3 | 3 | 6 | 7 | M |
| * 0 | 2 | 2 | 4 | 5 | 3 | 7 | M |
| * 2 | 4 | 3 | 3 | 4 | 5 | 8 | M |
| * 1 | 4 | 4 | 5 | 6 | 5 | 8 | F |
| * 0 | 1 | 0 | 0 | 1 | 3 | 5 | F |
| * 3 | 4 | 5 | 8 | 7 | 8 | 9 | M |
| * 0 | 1 | 2 | 2 | 5 | 5 | 10 | M |
| * 0 | 3 | 2 | 1 | 1 | 2 | 3 | M |
| 1 | 1 | 1 | 0 | 3 | 1 | 5 | M |
| 0 | 0 | 1 | 1 | 2 | 2 | 6 | M |
| 0 | 0 | 0 | 0 | 1 | 2 | 3 | F |
| 1 | 2 | 3 | 2 | 3 | 5 | 6 | M |
| 0 | 1 | 2 | 4 | 3 | 5 | 10 | M |
| 0 | 0 | 2 | 1 | 3 | 5 | 4 | F |
| 1 | 4 | 3 | 5 | 8 | 8 | 8 | F |
| 1 | 2 | 2 | 5 | 4 | 7 | 6 | F |
| 1 | 1 | 0 | 1 | 1 | 3 | 6 | M |
| 3 | 4 | 3 | 6 | 6 | 8 | 10 | F |
| 0 | 1 | 2 | 5 | 4 | 4 | 7 | F |
| 0 | 4 | 3 | 8 | 7 | 7 | 10 | F |
| 0 | 2 | 1 | 4 | 4 | 5 | 7 | F |

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Experiment #2 - P3

| | Response-Recall 10 trials | Paired-Associate Trial 1 | Trial 2 | Trial 3 | Written-Recall | Male or Female |
|---|---|---|---|---|---|---|
| First-Part | 95 | 2 | 5 | 4 | 4 | F |
| | 88 | 1 | 0 | 1 | 4 | M |
| | 72 | 2 | 4 | 3 | 7 | M |
| | 74 | 2 | 1 | 1 | 5 | M |
| | 70 | 0 | 2 | 0 | 3 | M |
| | 97 | 3 | 5 | 4 | 9 | M |
| | 96 | 1 | 1 | 1 | 5 | M |
| | 89 | 3 | 4 | 4 | 6 | M |
| | 81 | 1 | 4 | 4 | 7 | M |
| | 68 | 0 | 0 | 0 | 1 | M |
| | 91 | 2 | 6 | 6 | 9 | M |
| | 79 | 1 | 0 | 3 | 4 | F |
| | 97 | 0 | 4 | 3 | 8 | F |
| | 85 | 2 | 4 | 4 | 5 | M |
| | 88 | 3 | 2 | 1 | 5 | F |
| | 94 | 2 | 3 | 3 | 6 | F |
| | 89 | 2 | 0 | 0 | 3 | F |
| | 79 | 0 | 3 | 1 | 3 | M |
| | 89 | 1 | 2 | 4 | 4 | M |
| | 92 | 1 | 1 | 2 | 6 | M |
| Last-Part | 97 | 7 | 8 | 9 | 10 | F |
| | 90 | 5 | 9 | 9 | 10 | F |
| | 94 | 0 | 2 | 3 | 6 | M |
| | 63 | 1 | 2 | 1 | 3 | M |
| | 88 | 2 | 4 | 4 | 5 | M |
| | 89 | 4 | 3 | 2 | 2 | M |
| | 89 | 0 | 2 | 4 | 9 | M |
| | 96 | 0 | 2 | 5 | 6 | F |
| | 97 | 2 | 4 | 6 | 10 | F |
| | 66 | 2 | 3 | 1 | 3 | M |
| | 73 | 0 | 0 | 2 | 2 | M |
| | 96 | 1 | 1 | 2 | 5 | F |
| | 93 | 2 | 2 | 3 | 8 | F |
| | 86 | 2 | 1 | 0 | 3 | M |
| | 92 | 3 | 3 | 3 | 7 | F |
| | 96 | 4 | 6 | 6 | 10 | F |
| | 86 | 1 | 1 | 1 | 4 | F |
| | 86 | 2 | 3 | 4 | 4 | M |
| | 76 | 4 | 8 | 9 | 10 | M |
| | 87 | 0 | 0 | 1 | 5 | M |
| | 89 | 1 | 3 | 1 | 5 | M |

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Experiment #2 - NP3

| | Paired-Associate Trial 1 | Trial 2 | Trial 3 | Written-Recall | Male or Female |
|---|---|---|---|---|---|
| First-Part | 3 | 5 | 8 | 9 | M |
| | 1 | 0 | 2 | 2 | M |
| | 0 | 1 | 2 | 7 | M |
| | 1 | 0 | 0 | 2 | M |
| | 2 | 1 | 2 | 3 | M |
| | 0 | 2 | 1 | 1 | M |
| | 0 | 0 | 0 | 2 | M |
| | 1 | 4 | 5 | 8 | F |
| | 0 | 0 | 2 | 3 | M |
| | 0 | 1 | 0 | 2 | M |
| | 0 | 0 | 1 | 3 | M |
| | 1 | 0 | 1 | 4 | F |
| | 0 | 3 | 5 | 6 | M |
| | 2 | 0 | 2 | 3 | F |
| | 0 | 0 | 2 | 0 | M |
| | 1 | 4 | 5 | 9 | M |
| | 0 | 6 | 6 | 9 | M |
| | 1 | 3 | 4 | 5 | F |
| | 0 | 1 | 3 | 7 | M |
| | 1 | 1 | 3 | 4 | M |
| Last-Part | 6 | 8 | 8 | 10 | M |
| | 1 | 2 | 2 | 4 | M |
| | 4 | 4 | 5 | 8 | M |
| | 5 | 9 | 8 | 10 | F |
| | 4 | 5 | 7 | 10 | F |
| | 4 | 6 | 8 | 10 | F |
| | 1 | 1 | 1 | 3 | F |
| | 0 | 0 | 0 | 5 | F |
| | 0 | 1 | 1 | 2 | M |
| | 1 | 3 | 5 | 9 | M |
| | 2 | 0 | 0 | 4 | M |
| | 2 | 0 | 3 | 4 | M |
| | 0 | 0 | 0 | 0 | M |
| | 0 | 2 | 2 | 3 | M |
| | 0 | 0 | 0 | 1 | M |
| | 1 | 3 | 2 | 3 | F |
| | 1 | 3 | 4 | 7 | F |
| | 2 | 4 | 2 | 2 | M |
| | 0 | 0 | 0 | 0 | M |
| | 3 | 6 | 4 | 8 | M |
| | 0 | 1 | 5 | 4 | M |

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|---|---|---|---|---|
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# APPENDIX 4

Male-Female Division of Paired-Associate Scores

| | Male | | Female | |
|---|---|---|---|---|
| | n | Mean | n | Mean |
| Experiment #1 | | | | |
| P1 | 12 | 1.08 | 12 | 2.00 |
| NP1 | 11 | 1.36 | 13 | 2.23 |
| P3 | 13 | 10.77 | 11 | 9.64 |
| NP3 | 15 | 4.67 | 9 | 8.89 |
| P6 | 9 | 18.00 | 15 | 29.33 |
| NP6 | 12 | 13.83 | 12 | 19.50 |
| Experiment #2 | | | | |
| P3 | 26 | 6.62 | 15 | 9.53 |
| NP3 | 30 | 5.50 | 11 | 8.82 |

It can be seen that the females generally do better than the males, but there are inconsistencies. The results for the P3 and NP3 groups of Experiments #1 and #2 show that the males are responsible for the different results found in the two experiments.

# APPENDIX 5

## Introductory Psychology Marks as a Measure of Sampling Error

### 1. Mean Introductory Psychology Marks (Experiments #1 & #2)

| Experiment #1 | | | | | | Experiment #2 | |
|---|---|---|---|---|---|---|---|
| P1 | NP1 | P3 | NP3 | P6 | NP6 | P3 | NP3 |
| 61.76 | 56.43 | 60.02 | 60.98 | 62.88 | 60.68 | 58.62 | 63.33 |

### 2. Comparisons of Mean Introductory Psychology Marks

| Comparison | Difference | t | Variance | p (two-tail) |
|---|---|---|---|---|
| Experiment #1 | | | | |
| P1 - NP1 | 5.33 | 1.69 | homogeneous | $<.10$ |
| P3 - NP3 | -.96 | -.34 | homogeneous | $<.80$ |
| P6 - NP6 | 2.20 | .84 | homogeneous | $<.50$ |
| Experiment #2 | | | | |
| P3 - NP3 | -4.71 | -2.13 | homogeneous | $<.05$ |

For Experiment #2, the difference between the P3 mean-mark and the NP3 mean-mark was significant ($p < .05$). It seemed that insofar as Introductory Psychology marks measure learning ability, the NP3 Ss were of greater ability than the P3 Ss. To further test the

hypothesis that due to sampling error, the learning ability of the Ss in the two groups differed, two analyses of variance were carried out. One analysis was of the combined-trial paired-associate scores and the other of the written-recall scores. The data from 40 Ss were used. Five P3 group Ss and five NP3 group Ss from each of four Introductory Psychology mark levels were chosen for this analysis. The Introductory Psychology mark levels used were 30-50%; 50-60%; 60-70%; 70-80%. The marks of the Ss in each level were equated for the pretraining and no pretraining groups. The summary tables for these analyses are given below.

3. Summary Table of the Analysis of Variance (Introductory Psychology Mark Levels X Treatments) of Paired-Associate Scores (Combined-trials).

| Source of Variation | Sum of Squares | d.f. | Mean Square | F |
|---|---|---|---|---|
| Pretraining (Treatments) | 19.40 | 1 | 19.40 | $<1$ |
| Mark Levels (Blocks) | 26.10 | 3 | 8.70 | $<1$ |
| Residual | 1340.40 | 35 | 38.30 | |
| Within | 1304.00 | 32 | 40.75 | |
| Treatments X Blocks | 36.40 | 3 | 12.13 | $<1$ |
| Total | 1385.90 | 39 | | |

4. Summary Table of the Analysis of Variance (Introductory Psychology Mark Levels X Treatments) of Written-Recall Scores

| Source of Variation | Sum of Squares | d.f. | Mean Square | F |
|---|---|---|---|---|
| Pretraining (Treatments) | 12.10 | 1 | 12.10 | 1.34 |
| Mark Levels (Blocks) | 15.30 | 3 | 5.10 | $<1$ |
| Residual | 316.50 | 35 | 9.04 | |
| Within | 310.40 | 32 | 9.70 | |
| Treatments X Blocks | 6.10 | 3 | 2.03 | $<1$ |
| Total | 343.90 | 39 | | |

The variance due to treatments is not significant ($p > .25$)

# APPENDIX 6

## Experiment #2 - First Part and Last Part

### 1. Response-Recall Mean Scores

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| First Part | 5.60 | 7.25 | 8.40 | 8.60 | 8.80 | 9.05 | 9.10 | 9.35 | 9.75 | 9.75 |
| Last Part | 5.90 | 7.76 | 8.14 | 8.90 | 8.76 | 9.38 | 9.38 | 9.52 | 9.62 | 9.71 |

### 2. Paired-Associate & Written-Recall Mean Scores

| | Paired Associate Final-Trial | Paired Associate Combined-Trial | Written-Recall |
|---|---|---|---|
| First Part - P3 | 2.45 | 6.45 | 5.20 |
| - NP3 | 2.70 | 5.00 | 4.45 |
| Last Part - P3 | 3.62 | 8.85 | 6.35 |
| - NP3 | 3.19 | 7.71 | 5.35 |

3. Comparisons

| Comparison (P3 - NP3) | Difference | t | Variance | p (two-tail) |
|---|---|---|---|---|
| Paired-Associate (Final-Trial) | | | | |
| First-Part | -.25 | -.403 | homogeneous | $<.70$ |
| Last-Part | .43 | .494 | homogeneous | $<.70$ |
| Paired-Associate (Combined-Trials) | | | | |
| First-Part | 1.45 | 1.115 | homogeneous | $<.30$ |
| Last-Part | 1.14 | .533 | homogeneous | $<.60$ |
| Written-Recall | | | | |
| First-Part | .75 | .947 | homogeneous | $<.40$ |
| Last-Part | 1.00 | 1.021 | homogeneous | $<.40$ |